Tahoe-Truckee Sanitation Agency
Master Sewer Plan

VOLUME 2: COLLECTION SYSTEM MASTER PLAN

FINAL | February 2022

carollo

Master Sewer Plan

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Abbreviations

AACE	Association for the Advancement of Cost Engineering
AAF	average annual flow
ADWF	average dry weather flow
Agency	Tahoe-Truckee Sanitation Agency
ASCWD	Alpine Springs County Water District
BWF	base wastewater flow
C	capacity
Carollo	Carollo Engineers, Inc.
CEQA	California Environmental Quality Act
CIP	capital improvement program
CIPP	cured-in-place pipe
DHI	Danish Hydraulic Institute
DIP	ductile iron pipe
DS	digital scans
DWF	dry weather flow
ENR	Engineering News Record
EPA	Environmental Protection Agency
ERB	emergency retention basin
GIS	geographic information system
GWI	groundwater infiltration
HGL	hydraulic grade line
HOF	high occupancy flow
I/I	inflow and infiltration
ID	identifier
July 4th	Independence Day
LF	linear feet
Master Plan	Master Sewer Plan
MFR	multifamily residence/residential
MG	million gallons
mgd	million gallons per day
MH	manhole
NASSCO	National Association of Sewer Service Companies
NAVD88	North American Vertical Datum of 1988
NCSD	Northstar Community Services District
NOAA	National Oceanic and Atmospheric Association
NTPUD	North Tahoe Public Utility District
NYE	New Year's Eve

O	other
O&M	operation and maintenance
OVPSD	Olympic Valley Public Service District
PACP	Pipeline Assessment Certification Program
PDR	preliminary design report
PF	peaking factor
PWWF	peak wet weather flow
R&R/RR	replacement and rehabilitation
RCP	reinforced concrete pipe
RDII	rain-derived infiltration and inflow
ROW	right-of-way
RSC2	Resort at Squaw Creek Phase 2
SFR	single-family residence/residential
sq ft	square feet
SRV	surface reinforcement visible
SSO	sanitary sewer overflow
SWMM	Storm Water Management Model
TCPUD	Tahoe City Public Utility District
TDPUD	Truckee Donner Public Utility District
TM	Technical Memorandum
TRI	Truckee River Interceptor
TRPA	Tahoe Regional Planning Agency
TSD	Truckee Sanitary District
T-TSA	Tahoe-Truckee Sanitation Agency
UWMP	Urban Water Management Plan
VSVSP	Village at Squaw Valley Specific Plan
WaPUG	Wastewater Planning Users Group
WDRs	Waste Discharge Requirements
WRP	Water Reclamation Plant
WWF	wet weather flow

Tahoe-Truckee Sanitation Agency
Master Sewer Plan

VOLUME 2:
COLLECTION SYSTEM MASTER PLAN
CHAPTER 1:
DESCRIPTION OF EXISTING FACILITIES

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Chapter 1

DESCRIPTION OF EXISTING FACILITIES

This chapter provides an overview of Tahoe-Truckee Sanitation Agency's (T-TSA's) interceptor system, known as the Truckee River Interceptor (TRI), and a detailed description of the associated facilities.

T-TSA owns, operates, and maintains the TRI and regional Water Reclamation Plant (WRP). T-TSA is designated as the regional entity to transport, treat, and dispose of wastewater from five member districts: North Tahoe Public Utility District (NTPUD), Tahoe City Public Utility District (TCPUD), Alpine Springs County Water District (ASCWD), Olympic Valley Public Service District (OVPSD), and Truckee Sanitary District (TSD). (Northstar Community Services District (NCSD) also contributes wastewater to T-TSA, via TSD's sewer collection system, and is not considered a member district, although it is a contributing agency).

The TRI conveys wastewater by gravity flow from the north and west Lake Tahoe region through Tahoe City following the Truckee River, and ultimately to the WRP. Wastewater from the member districts enters the TRI at various manholes; T-TSA does not allow direct sewer connections to the TRI. Since the majority of the TRI follows the Truckee River, much of it is located in a flood plain and the TRI crosses the Truckee River a number of times.

The WRP is located in Martis Valley east of the Town of Truckee, California. Advanced wastewater treatment occurs at the WRP through a series of biological, chemical, and physical processes, treating the wastewater to protect the quality of groundwater and surface water.

Figure 1.1 presents the interceptor system service area for T-TSA.

1.1 Interceptor System Facilities

The interceptor system consists of the TRI and its associated appurtenances, including 19.5 miles of gravity interceptor system pipe (varying in diameter from 18 to 42 inches), and 181 manholes. T-TSA interceptor system facilities include the following:

- Interceptor Sewers: Interceptor sewers are defined as gravity sewers with diameters of 18 inches and larger.
- Special Structures: Flow diversions are defined as locations in the interceptor system where upstream flow may be split between two (or more) downstream pipelines. The amount of flow that is diverted from the main downstream pipeline is a function of the system configuration (i.e., pipeline diameters, inverts, weirs, slide gates, sluice gates, etc.). Other special structures include a crossover structure, control structures, and measuring flumes.
- River Crossings: River crossings are defined as locations where the TRI crosses the Truckee River. The TRI crosses under the Truckee River at eight locations.

Given T-TSA's unique agreement with its five member districts, T-TSA does not own or operate any gravity sewer mains or gravity sewer laterals. The TRI was constructed such that all wastewater flows via gravity; therefore T-TSA does not own or operate any sewer force mains or sewer lift stations.

Figure 1.2 shows the existing T-TSA interceptor system and Figure 1.3 shows the TRI's existing flow diversion structures.

1.1.1 Gravity Sewers

Table 1.1 presents a summary by diameter of T-TSA gravity sewers. As shown in Table 1.1, approximately 13 percent of the system is 24 inches in diameter, approximately 14 percent of the system is 27 inches in diameter, and approximately 20 percent of the system is 30 inches in diameter, with the majority (34 percent) being 33 inches in diameter.

Table 1.1 Interceptor System Gravity Pipeline Diameter Summary(1)

Pipe Diameter (inches)	Length (miles)	Percent of System (by Length) (2)
18	0.01	0.1
24	2.59	13.3
27	2.71	13.9
30	3.97	20.3
33	6.69	34.3
36	1.62	8.3
42	1.92	9.8
Total	**19.52**	**100.0**

Notes:
(1) Source: T-TSA record drawings and GIS data base.
(2) Numbers may vary slightly due to rounding.

Table 1.2 summarizes the interceptor system by pipe material. As shown in Table 1.2, the majority of the TRI (approximately 96 percent) consists of reinforced concrete pipe (RCP).

Table 1.2 Interceptor System Gravity Pipeline Material Summary(1)

Pipe Material	Length (miles)	Percent of System (by Length)
Reinforced Concrete Pipe	18.67	95.7
Cured-in-Place-Pipe	0.42	2.1
Ductile Cast Iron	0.43	2.2
Total	**19.52**	**100.0**

Notes:
(1) Source: T-TSA record drawings and GIS data base.

Carollo Engineers, Inc. (Carollo) built a geographic information system (GIS) database using information from T-TSA's maps, sewer inspection reports, and record drawings, as well as information from El Dorado County, Nevada County, Placer County, Tahoe Regional Planning Agency, and the contributing sewer agencies. Detailed information regarding T-TSA's interceptor system is compiled in the GIS database.

Figure 1.4 and Table 1.3 summarize the available data by installation decade. As shown in both Figure 1.4 and Table 1.3, the majority of the TRI was installed in the 1970s and is over 40 years old.

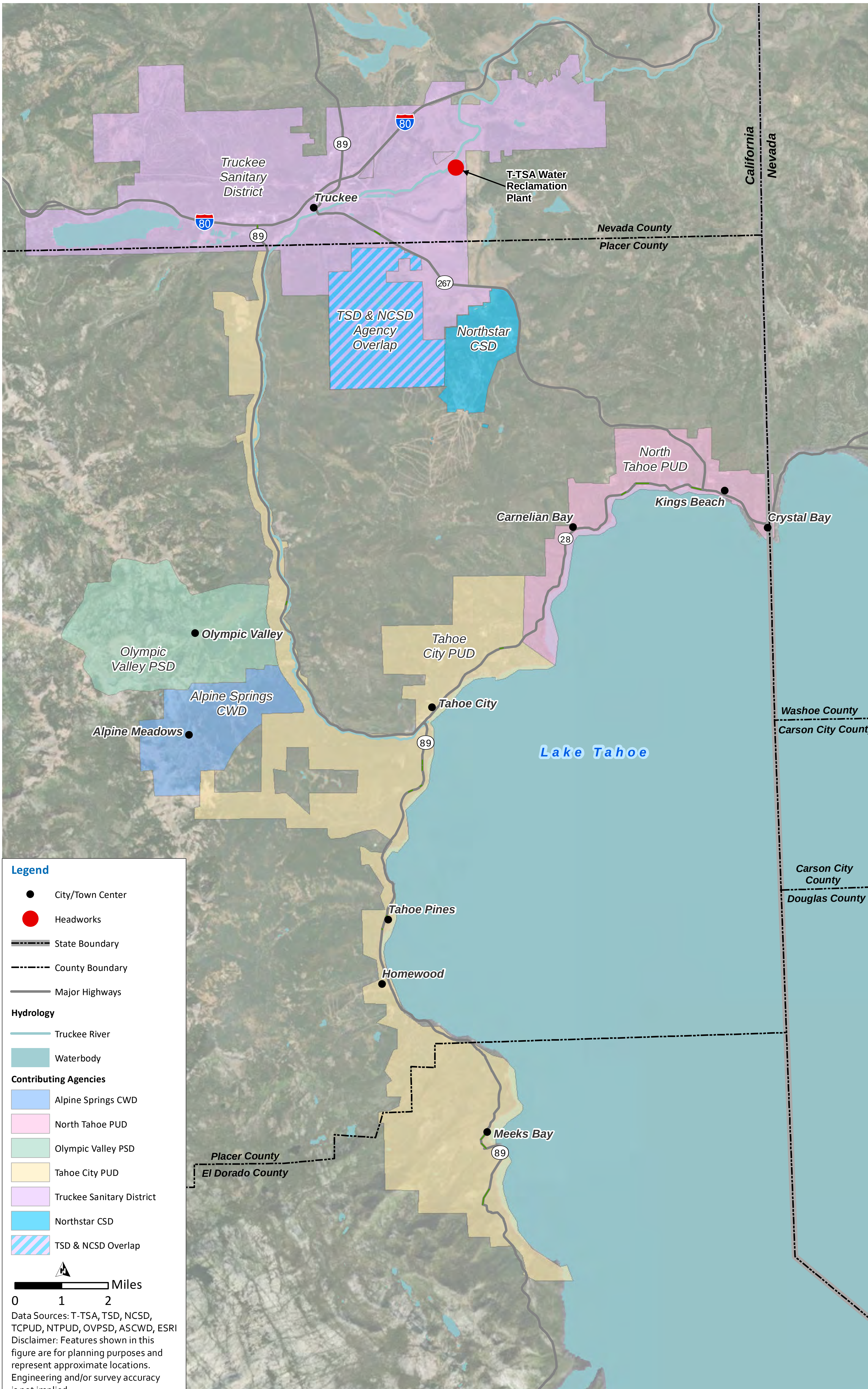

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Figure 1.1 T-TSA Service Area

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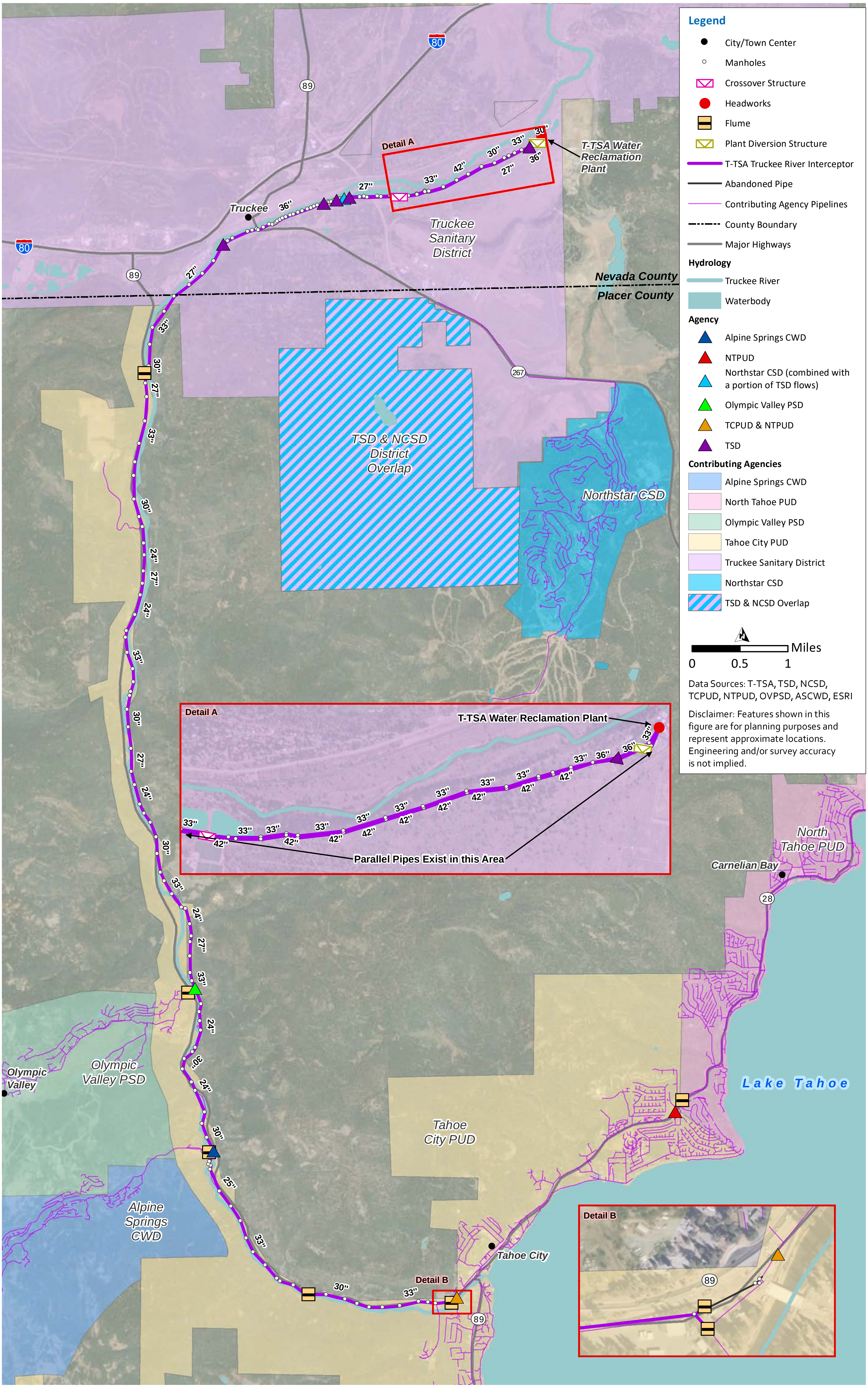

Figure 1.2 Existing Truckee River Interceptor System

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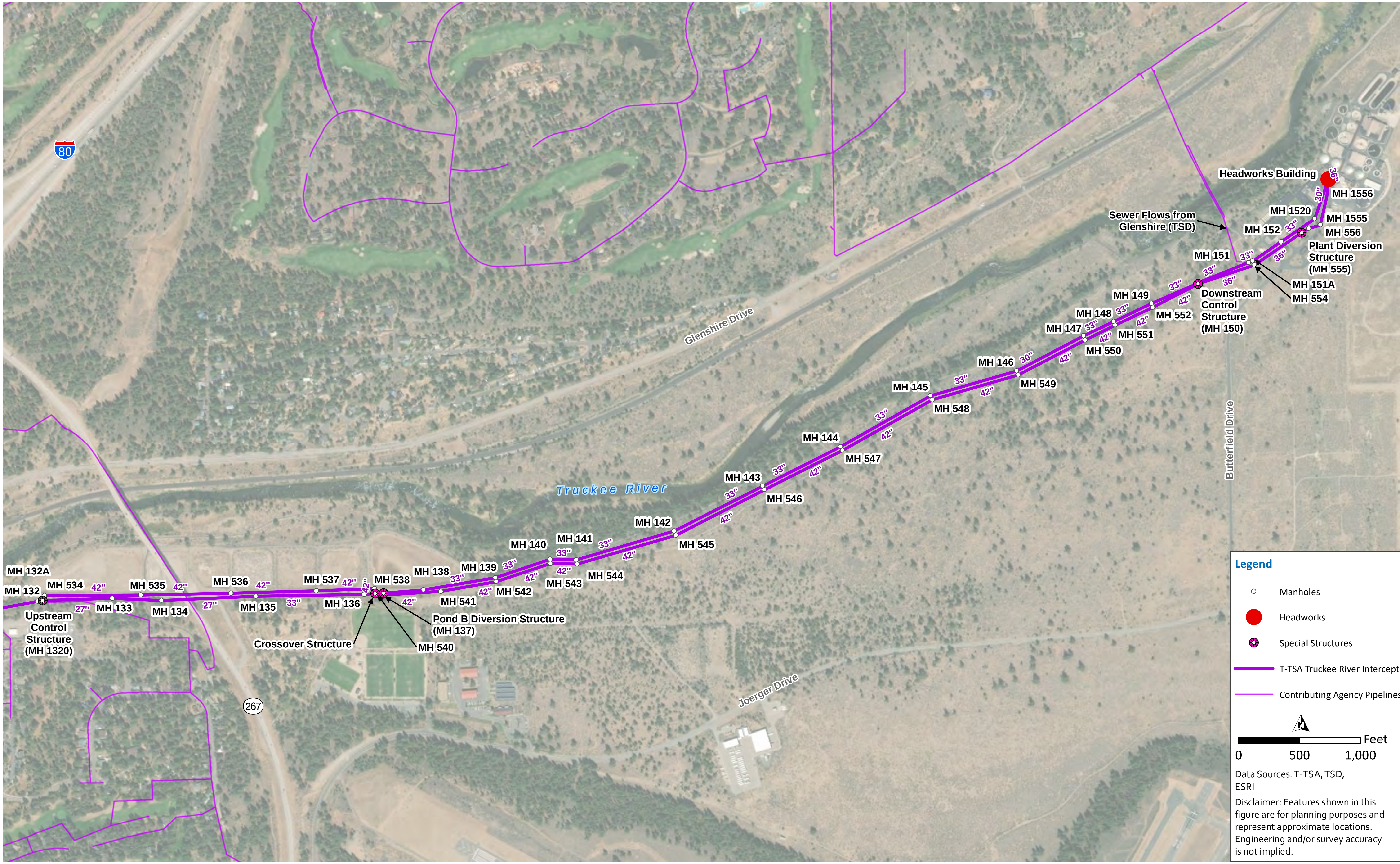

Figure 1.3 Existing TRI Flow Diversion Structures

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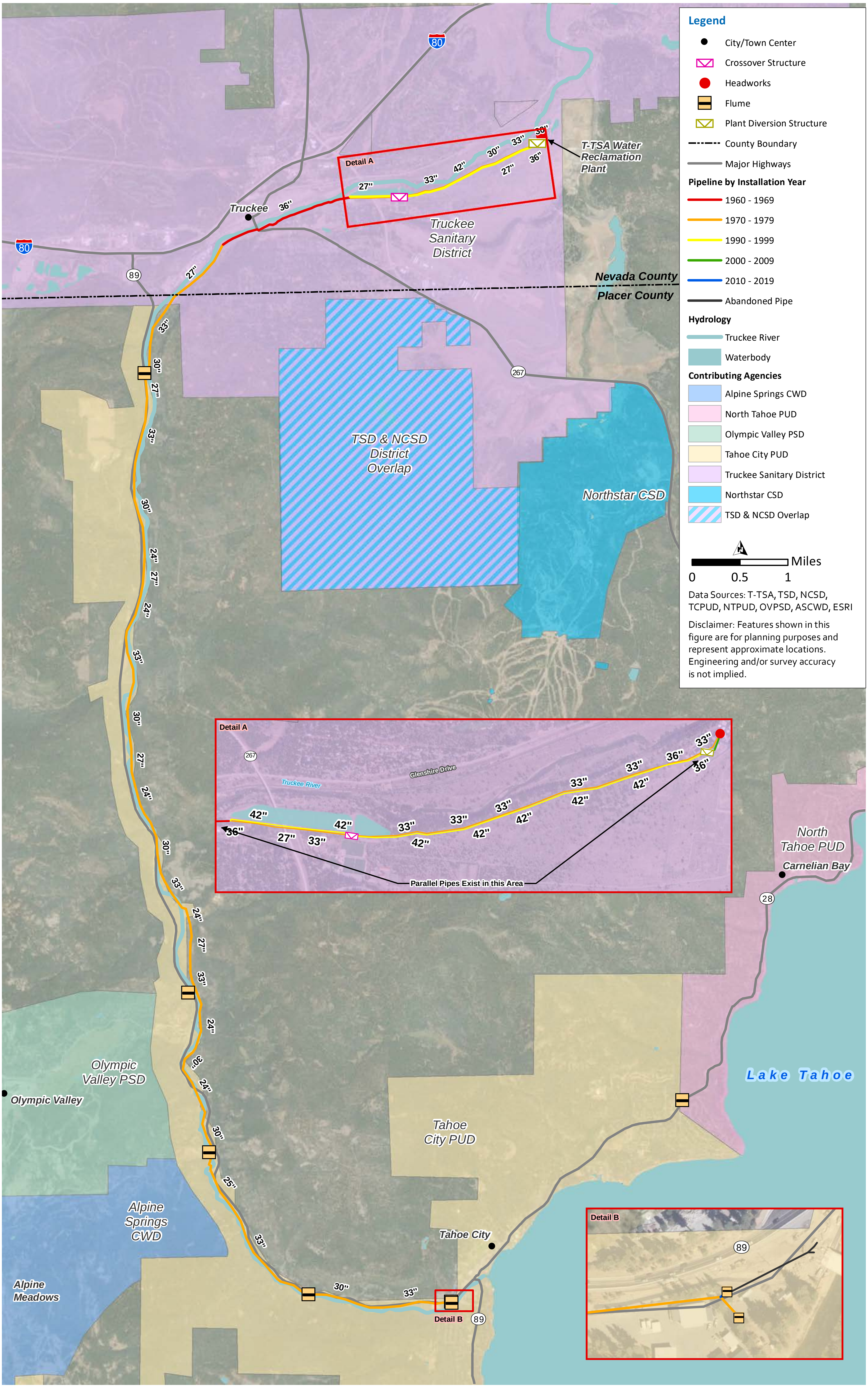

Figure 1.4 Pipeline Installation by Decade

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Table 1.3 Interceptor System Pipeline Installation Date Summary[1]

Decade	Length (miles)	Percent of System (by Length)
1960 – 1969	1.42	7.3
1970 – 1979	15.85	81.1
1980 – 1989	--	--
1990 – 1999	2.11	10.8
2000 – 2009	0.09	0.5
2010 – 2019	0.07	0.4
Total	**19.54**	**100.0**

Notes:
(1) Source: T-TSA record drawings and GIS data base.

1.1.2 Special Structures

The TRI includes several important flow diversion structures on the TRI as it approaches the WRP. These flow diversion structures can be used to divert flows to emergency retention basins during high flow events.

T-TSA owns eight ponds located on the south bank of the Truckee River west of the existing subsurface disposal fields for the WRP. All of the ponds are considered to be independent storage basins, although ponds "A", 2, 3, 4, 5, and "B" may have originally been interconnected, and ponds "D-1" and "D-2" may have originally been interconnected. Flows from Pond B can be diverted to the D ponds via the Pond D Pump Station located at the southeast corner of Pond B. This pump station includes two vertical turbine pumps which pump into a discharge header that goes uphill to the D ponds.

Ponds are filled with a safe margin of freeboard and extra storage. The usable combined storage capacity of Ponds "A", 3, "B," "D-1," and "D-2" is approximately 24 million gallons (MG). Additional storage capacity is potentially available in Ponds 2, 4, and 5; however, T-TSA considers the use of these ponds as a "last-resort," given that they are unlined and in close proximity to the Truckee River. The WRP also has an onsite emergency retention basin with usable storage capacity of 7.8 MG. More information about the emergency storage basins can be found in Volume 3, Chapter 1 - Description of Existing Facilities.

Figure 1.5 shows the location of the offsite emergency storage ponds.

The following summarizes the diversion structures:

- Manhole (MH) 132A: This manhole has a 27-inch outlet pipe allowing wastewater to flow into MH 132 and subsequently to MH 1320. This manhole also contains a secondary outlet pipe to a gate valve that can be used to divert all or a portion of flow from the TRI to Pond A. The gate valve is typically fully closed.
- Upstream Control Structure (MH 1320): This structure has a 27-inch inlet pipe and a 27-inch outlet pipe, which is controlled by a sluice gate that is typically fully open. Wastewater from this structure flows to MHs 133 to 136, and subsequently to the WRP. This structure also includes a weir overflow to divert all or a portion of flow from the TRI through a parallel 42-inch interceptor to the Crossover Structure. The slide gate to the weir overflow is typically fully closed.

- Crossover Structure: This structure has a 33-inch inlet pipe controlled by a typically open slide gate and a 33-inch outlet pipe with a typically open sluice gate. Wastewater from this structure flows to the Pond B Diversion Structure (MH 137), and then onto the WRP. The Crossover Structure also has a slide gate to receive weir overflows from the Upstream Control Structure (MH 1320) via the parallel 42-inch interceptor, and a slide gate to divert flows to the Downstream Control Structure (MH 150) via the parallel 42-inch interceptor. The slide gate to the Downstream Control Structure (MH 150) is typically fully closed.
- Pond B Diversion Structure (MH 137): This structure has a 33-inch inlet pipe and a 33-inch outlet pipe, with a typically open sluice gate, allowing wastewater to flow into MHs 138 to 149, then into the Downstream Control Structure (MH 150). This structure also contains a weir overflow with a sluice gate to divert flow to Pond B. The sluice gate to Pond B is typically fully closed.
- Downstream Control Structure (MH 150): This manhole structure has one 33-inch inlet pipe controlled by a normally open slide gate, and a 33-inch outlet pipe controlled by a normally open sluice gate. Wastewater from this structure flows to MH 151 where wastewater from the Glenshire neighborhood enters the TRI. The combined wastewater then flows to MHs 151A, 152, and 1520, before entering the WRP Headworks. This structure also receives flow from the upstream Crossover Structure, via the parallel 42-inch interceptor, controlled by a slide gate. Flows can be diverted from this structure via a 36-inch outlet controlled by a normally closed sluice gate to MH 554, and then to the Plant Diversion Structure (MH 555).
- Plant Diversion Structure (MH 555): Diverted flows from the Downstream Control Structure (MH 150) enter this structure via a 36-inch inlet pipe. An 18-inch outlet pipe controlled by a typically closed sluice gate diverts flow to MH 556 and then to the WRP's Emergency Retention Basin. This structure also contains a sluice gate to a separate chamber, which has a 30-inch outlet controlled by another sluice gate where wastewater flows to MHs 1555 and 1556, and then to the WRP Headworks. The Plant Diversion Structure (MH 555) is typically only used during high flow scenarios.
- Headworks: The Headworks facility is where all flows enter the WRP for processing. Flows pass through bar screens to remove large debris, a Parshall flume for measuring, and grit chambers to remove grit and sediment before Primary Treatment. More information regarding this facility can be found in Volume 3, Chapter 1 - Description of Existing Facilities.

The location of these structures is shown in Figure 1.3, and a schematic showing these structures is shown in Figure 1.6.

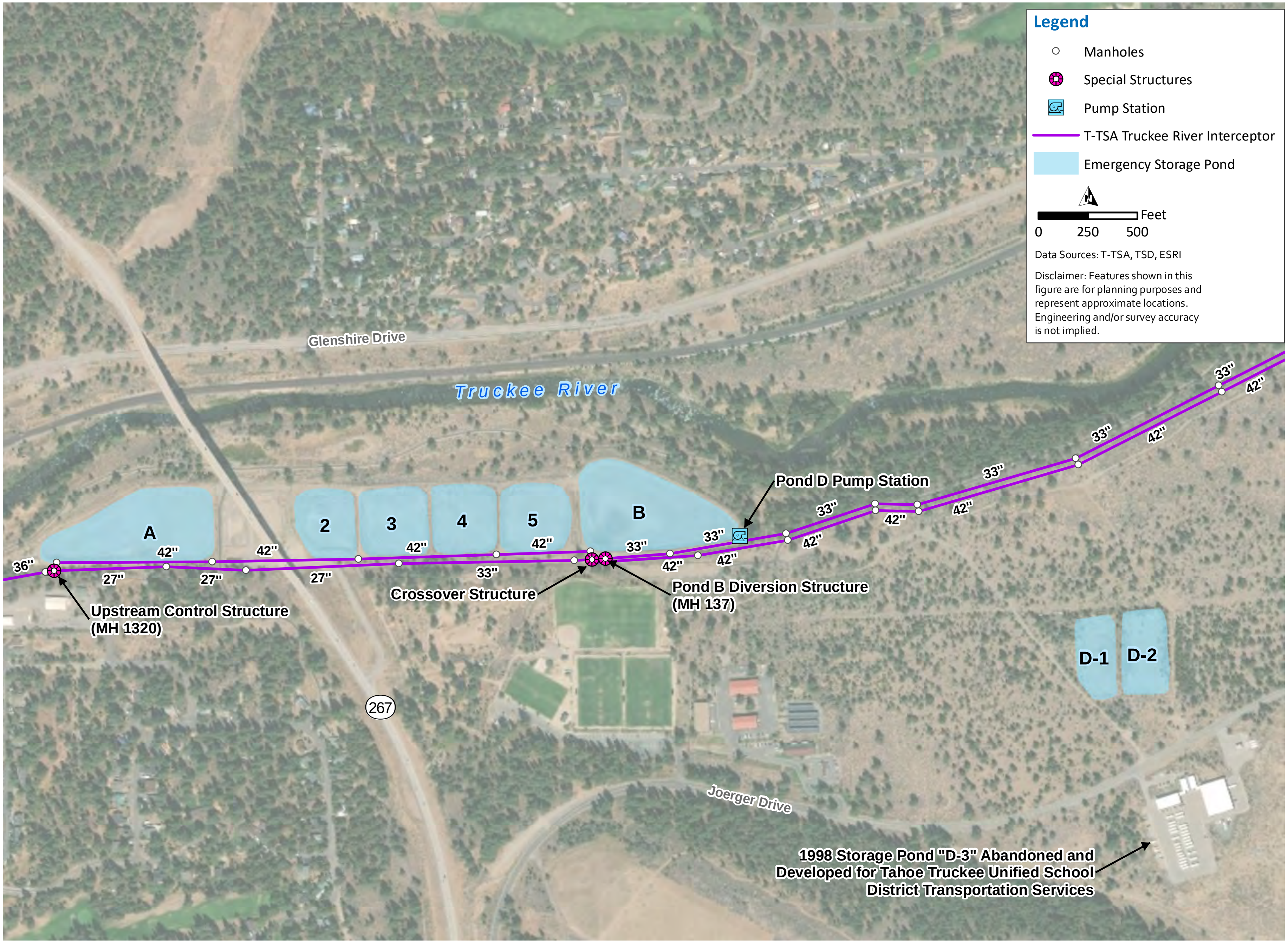

Figure 1.5 Emergency Storage Ponds

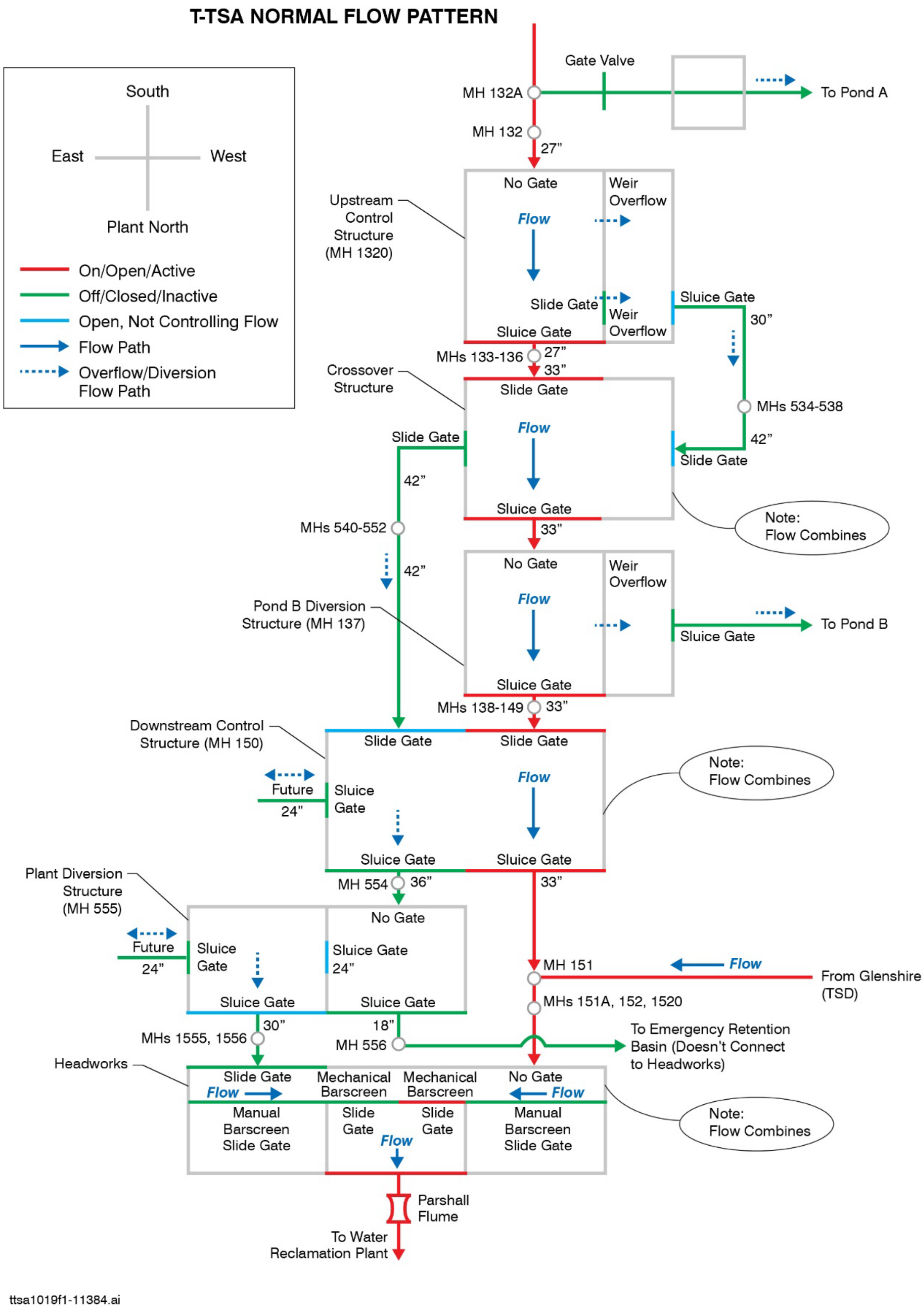

Figure 1.6 Flow Diversion Structure Schematic

Tahoe-Truckee Sanitation Agency
Master Sewer Plan

VOLUME 2: COLLECTION SYSTEM MASTER PLAN
CHAPTER 2: CONDITION ASSESSMENT AND ASSET MANAGEMENT

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Chapter 2

CONDITION ASSESSMENT AND ASSET MANAGEMENT

2.1 Introduction

The Tahoe-Truckee Sanitation Agency (T-TSA/Agency) provides wastewater treatment and collection for the North Lake Tahoe and Truckee region. T-TSA owns and operates the Water Reclamation Plant (WRP) located along the Truckee River in the eastern portion of the Town of Truckee near the intersection of the Truckee River and Martis Creek. Wastewater is conveyed to the WRP via the Truckee River Interceptor (TRI). The TRI flows south to north and begins in Tahoe City and follows the Truckee River and State Highway 89 to the Town of Truckee.

T-TSA has contracted with Carollo Engineers, Inc. (Carollo) to assist in developing its Master Sewer Plan (Master Plan). As a part of this Master Plan, Carollo reviewed the Agency's existing inspection data for the TRI and develop recommendations related to anticipated rehabilitation and replacement (renewal) projects. The purpose of this chapter is to share the condition assessment results with T-TSA. The condition of the TRI and its appurtenances was then used to prioritize TRI rehabilitation projects and develop annual capital cost expenditures as part of the overall Capital Improvement Program (CIP).

The primary goals of this project were to develop and implement transparent and defensible processes that will:

- Improve efficiencies in capital planning, operations, maintenance, and mission-critical support functions.
- Improve the rationale for prioritizing projects (e.g., optimize and standardize the process for considering the need, timing, and costs of CIP projects).
- Improve data collection and analysis (e.g., improve fundamental data and information mapping to support sound planning and engineering decisions).
- Optimize long-term spending priorities to account for the assets' life-cycle costs, the interdependencies of projects (eventually including between treatment and collection systems), and impacts to the customers.

2.2 Project Approach

To support long-term management of the TRI, condition assessment data were used to develop a TRI Renewal Program. The TRI Renewal Program prioritizes renewal projects within the capital program. A vital component of a Renewal Program is understanding the condition of the assets, determining remaining useful service life, and evaluating risk. In order to focus resources on the

TRI segments with the greatest needs, a data-driven decision-making process was utilized to understand the condition for individual TRI segments. The key tasks of the project included:

- Data Collection and Review – Collect data related to the TRI condition assessment and inspections. Review data, identify issues related to data quality or defect coding. Recommend a data set to be used for the condition assessment.
- Data Management – Build a central database to store inspection data. Standardize a recommended data set to better understand the condition of each TRI segment.
- Renewal Program – Use the inspection data to recommend renewal projects and develop a prioritized renewal plan.

2.2.1 NASSCO Background

Carollo was tasked with using the T-TSA's inspection data to develop a renewal program. The historical inspections identified defects along the sewer segments and assigned defect codes that were either structural or operation and maintenance (O&M) in nature. The assigned defect codes used the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program (PACP) scoring system. The PACP scoring standard uses a scale of 1 through 5 to denote the condition of each segment. The descriptions of the five defect categories (codes) are summarized below:

- 5: Most Significant.
- 4: Significant.
- 3: Moderate.
- 2: Minor to Moderate.
- 1: Minor.

The defect codes help identify renewal projects and maintenance needs, as well as help prioritize projects.

2.3 Data Collection and Review

This section summarizes the data collected and reviewed. The primary source of the TRI asset data was the T-TSA geographic information system (GIS) described below. Additional sources of key information include T-TSA's digital scans (DS) inspection data, maintenance tables, desktop analysis (spreadsheet), and Agency staff input.

2.3.1 GIS Data

Carollo built a GIS database using information from T-TSA's maps, sewer inspection reports, and as-built plans, as well as information from El Dorado County, Nevada County, Placer County, Tahoe Regional Planning Agency, and the contributing sewer agencies. Detailed information regarding T-TSA's interceptor system was compiled in the GIS database.

The TRI is approximately 19.5 miles long. The diameter of the TRI ranges between 18-inch to 42-inch, with 33-inch as the most prevalent pipe diameter, accounting for approximately 34 percent of the entire length of the TRI. The TRI consists of three materials; reinforced concrete pipe (RCP) being the most prevalent pipe material, accounting for approximately 96 percent of the entire length of the TRI. A majority of the TRI was installed in the 1970s, accounting for approximately 86 percent of the entire length. See Volume 2, Chapter 1 - Description of Existing Facilities for additional details.

2.3.2 Digital Scan Inspection Data

T-TSA regularly inspects the TRI every 3 to 4 years by schedule, as illustrated in Figure 2.1. The DS inspections were conducted by Agency staff as well as inspection contractors, and used the standardized NASSCO PACP scoring system. The data included DS inspections conducted since 2012 in various file formats. Carollo reviewed the provided DS inspection data from 2013 through 2018. (T-TSA inspected the TRI in 2019 and 2020 as well; however, DS data for these years were not available at the time of Carollo's analysis and were therefore not included.) T-TSA provided external hard drives that contained data including inspection databases, shapefiles, digital scans, and reports. The data format varied depending on the year. Before 2016, inspection data consisted of scanned reports and no databases. These reports were converted using Excel and then checked for accuracy. After 2014, there were a total of three separate contractor DS databases for 2016, 2017, and 2018 inspections in multiple formats. In most cases, multiple databases were created for each inspection set. The data also included some duplicate inspections.

Some of the TRI segments have had multiple inspections since 2012. Since the data were in multiple formats, T-TSA has not been able to easily track the TRI condition over time. The DS inspections did not have a unique pipe identifier (ID) that matched with the GIS data provided. Table 2.1 summarizes the TRI segments inspected by year.

Table 2.1 Digital Scan Inspection Data(1)

Upstream Structure	Downstream Structure	Inspection Year(s)
MH-02(2)	MH-53	2014, 2019(3)
MH-53	MH-98	2013, 2016, 2018
MH-98	WRP	2014, 2017, 2020(3)

Notes:
(1) Source: T-TSA DS data (2013, 2014, 2016, 2017, 2018, 2019, 2020).
(2) The original TRI section up to MH 2 no longer exists and has been replaced by TCPUD/NTPUD joint sewerage facilities.
(3) DS data from 2019 and 2020 were not available at the time of this analysis and were therefore not used.
Abbreviations: MH = manhole.

After reviewing the DS data, Carollo determined that a central database would need to be built using the various data formats in order to collate and sort all data. DS inspections and associated condition scores were available for nearly 100 percent of the TRI. However, during the process of converting data to a uniform format, there were inconsistencies found in the scoring of pipe segments with multiple inspection years. In some cases, the most recent inspection report showed that a pipe segment was in better condition compared to historical inspection reports. Therefore, for that reason, the DS inspection data were not used to build a central database.

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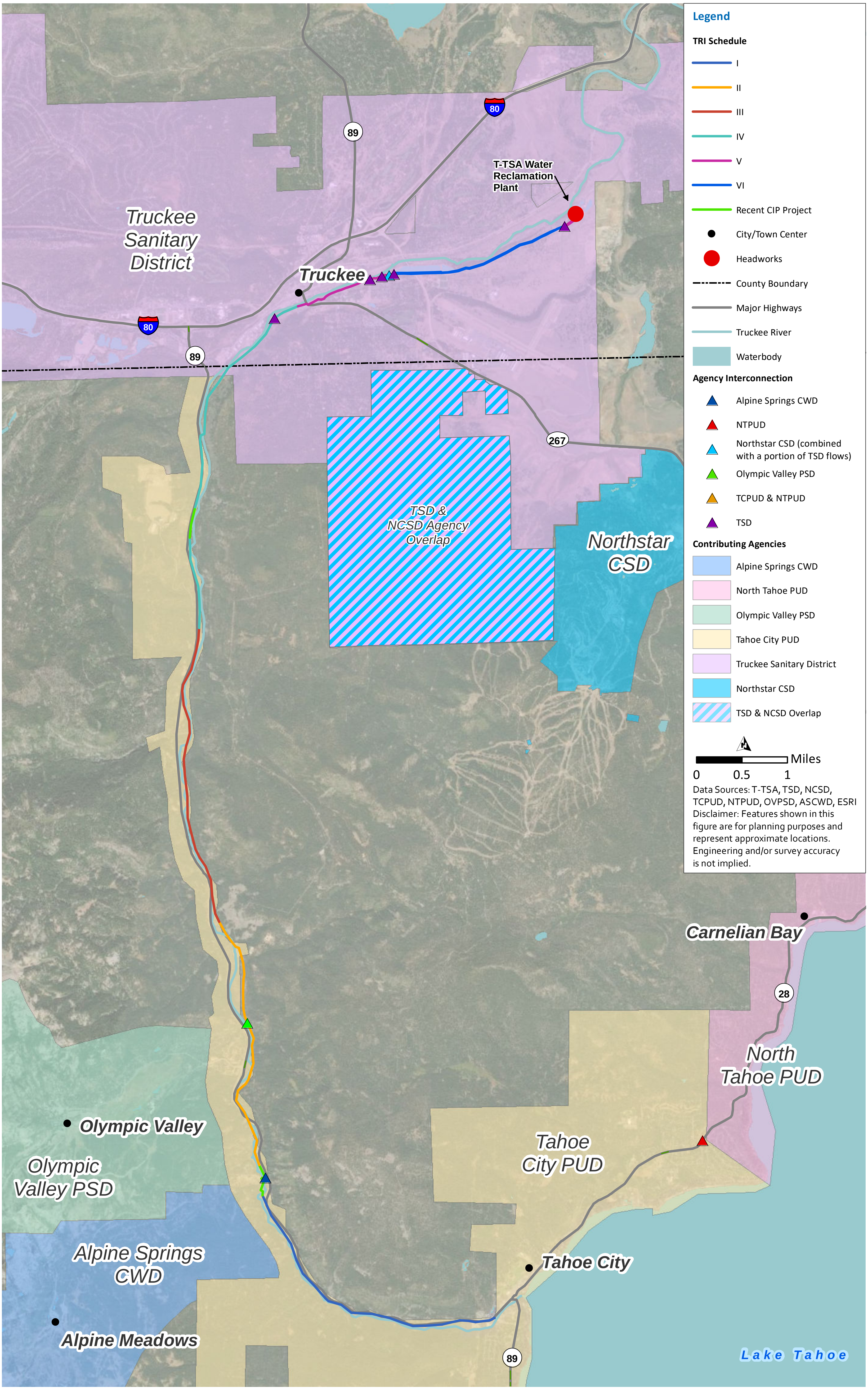

Figure 2.1 TRI by Schedule

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2.3.3 Maintenance Tables

T-TSA also provided two maintenance tables. These data included pipe segment defects for various inspection years as summarized in Table 2.2. The maintenance tables include contractor-identified defects as well as defects not identified by the contractor. Defects that were not identified by the contactor were either identified by T-TSA or other consultants. Defects that were identified by T-TSA were assigned a defect grade based on the grade of similar defects identified by the contractor.

Some of the important information tracked by the maintenance tables includes the condition (defect name), year the defect was identified, where the defect occurred along the pipe segment, defect grades, and start and finish points. The maintenance table data included repeat defects and made it difficult to identify the length of continuous defects. Furthermore, some defects were not assigned defect codes. However, the maintenance tables had the most complete set of data available and for that reason were used to build a central database.

Table 2.2 Maintenance Table Data(1)

Upstream Structure	Downstream Structure	Maintenance Table Year	Inspection Year
Flume	MH-53	2016	2012, 2013, 2014
MH-53	MH-98	2016	2013, 2016
MH-98	Headworks	2017	2014, 2017

Notes:
(1) Source: T-TSA Maintenance Tables (2016, 2017).

2.3.4 Data Review and Manipulation

The maintenance tables were used to develop a central database because they contained a complete data set. The inspection data were aggregated with the maintenance data into a complete data set to provide a single view of the TRI historical conditions scores for both O&M and structural ratings. To provide consistency, the following changes to the raw data were made.

- Defects were assigned a NASSCO PACP defect code based on the pipe condition from the maintenance table.
- Defect notes were used to assign a defect code when the maintenance table's condition was not similar to a PACP defect description. The maintenance table defect grade was assumed when the defect code grade varied based on actual conditions.
- In the case of 'Surface Other' defects, the maintenance table defect grade was used instead of the PACP grade of 0. 'Surface Other' defects were assigned PACP codes and grades based on any applicable notes in the maintenance tables if available.
- Defects with grades of 4 and 5 were reviewed to determine if the defect was a repeat defect.
- 'Continuous defects' was not used because the data format did not allow for ease of use. Instead, such continuous defects were counted as individual defects and assigned PACP codes and grades as appropriate.

The developed central database utilizes individual observations and defect coding to determine the condition of each pipeline. Figure 2.2 shows the breakdown of the peak defect score for each segment of the TRI. Approximately 0.8 miles (4 percent) of the TRI found no defects, 9.6 miles (49 percent) have minor to moderate defects (grades 1, 2, or 3) and 9.2 miles (47 percent) have significant defects (grades 4 or 5). Table 2.3 summarizes the defect grades by structural and O&M defects. The majority of the grade 4 and 5 defects were the result of suspected manufacturing defects where pipeline reinforcement is visible. Due to the nature of these defects, Carollo and the District have reviewed historical inspection data to determine if these defects are degrading over time. Based on this analysis, it was determined that the there is no immediate risk of failure.

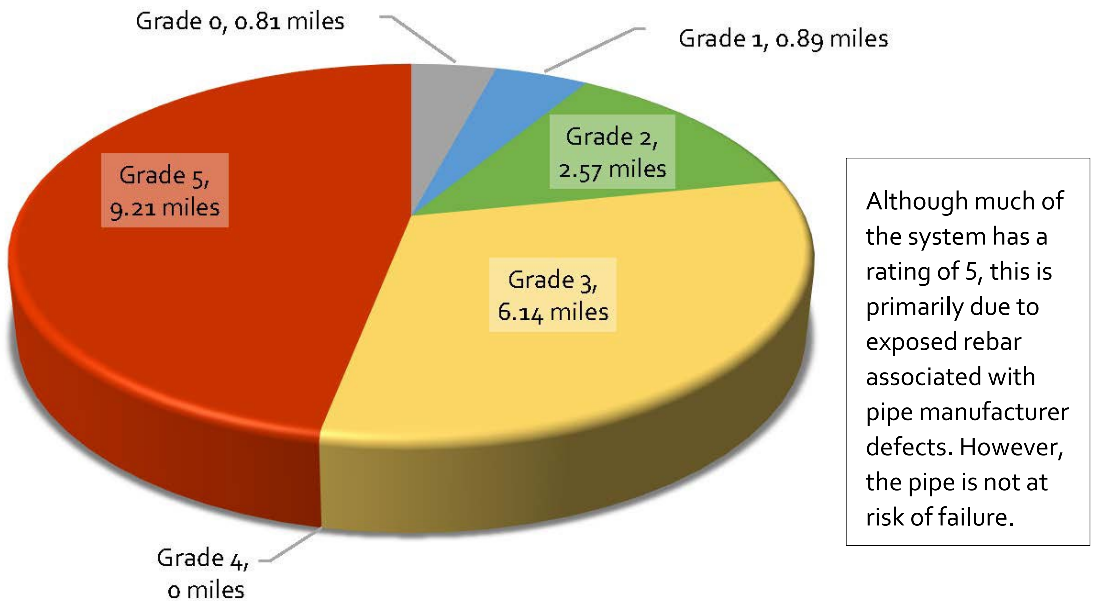

Figure 2.2 Inspection Scoring Summary

Table 2.3 Inspection Scoring Summary by Type

Defect Grade[(1)]	Structural Defects (miles)	Structural Defects (percent)	O&M Defects (miles)	O&M Defects (percent)
5	9.21	47.0	0.11	0.6
4	0.00	0.0	0.08	0.4
3	4.77	24.3	2.78	14.2
2	1.39	7.1	9.35	47.7
1	2.74	14.0	0.91	4.7
None	1.50	7.6	6.39	32.6

Notes:
(1) Although much of the system has a rating of 5, this is primarily due to exposed rebar associated with pipe manufacturer defects. However, the pipe is not at risk of failure.

Structural defects resulting in a defect grade of 5 were: surface reinforcement visible (69), reinforcement corroded (13), and reinforcement projecting (3). Some notable O&M defects that could impact the renewal projects include: water level sag (12) and alignment down/left/right (7).

The amount of pipe segments with surface reinforcement visible (SRV) defects raised concerns with regards to the structural integrity of these pipes. However, the SRV defects appear to be manufacturer defects. Furthermore, the PACP grades are not indicative of a failing pipeline. T-TSA's DS contractor defaulted to assigning a defect grade of 5 for an entire pipeline segment even when very little of the surface reinforcements were showing. Carollo differentiated these pipe segments by considering the pipe to be in poor condition if other aggregate codes are associated with the SRV. Carollo also reviewed a select sample of pipe segments with SRV defects and compared 2013 DS data with 2016 DS data to ascertain whether deterioration had occurred in that time frame. This review showed no significant change in pipe condition, which is why immediate replacement of these pipe segments has not been recommended in this Master Plan. Instead, this Master Plan recommends that a Visible Reinforcement Study be conducted to better understand the structural integrity of these pipe segments, and that a TRI Renewal Program be included to address sewer infrastructure that is susceptible to failure. The TRI Renewal Program would rehabilitate or replace any pipe segments with SRV defects if they are determined to be susceptible to failure during the Visible Reinforcement Study.

Given the concerns about SRV defects, tempered with the Agency's experience in operating the TRI, as well as Carollo's review of DS data for select pipe segment samples, a prudent approach is to review pipelines with SRV defects to determine the appropriate plan to address these defects. These pipelines need to be lined at some point, but maybe not immediately, as the PACP score would indicate. During the July 9, 2020 meeting, T-TSA staff noted that they plan to continue to carefully inspect these pipe segments with SRV defects when the segments are scheduled for routine DS in order to better monitor their condition and degradation. Figure 2.3 shows an example of an SRV defect, where the original rebar reinforcement in the RCP is visible.

Figure 2.3 Example: Surface Reinforcement Visible (SRV) Defect

2.4 TRI Renewal Program

Given the TRI's existing condition, replacement and rehabilitation (R&R/RR) projects are recommended to renew the TRI. The TRI Renewal Program framework used the defect coding from the data to determine the type of action needed (repair, rehabilitation, or replacement) for each pipe segment. Not all defect codes indicate the need to repair or rehabilitate a pipe. For example, excessive grease deposits require cleaning and no other actions. Also, the TRI Renewal Program considers sensitive areas such as proximity to the Truckee River and expected service life when prioritizing and recommending actions. This TRI Renewal Program can be used to develop a schedule of projects for the TRI over a 25-year period, broken into five phases and prioritized based on condition, expected service life, and other considerations:

- Phase 1: Years 2021 through 2025.
- Phase 2: Years 2026 through 2030.
- Phase 3: Years 2031 through 2035.
- Phase 4: Years 2036 through 2040.
- Phase 5: Years 2041 through 2045.

2.4.1 Truckee River Crossings

The TRI crosses under the Truckee River in a number of locations, and should these sections of the TRI fail, the consequence of a sewer pipeline failure within the banks of the Truckee River is extremely high. The TRI river crossings are ductile iron pipe (DIP). The inspections show that some of these crossings are experiencing corrosion issues, and it appears that the cement mortar lining in these pipes is gone. For these reasons, the TRI river crossings are considered to be Phase 1 renewal projects recommended to occur between 2021 and 2025. The rehabilitation projects described below were triggered because of the consequence of failure due to their location:

- *River Crossing, Gravity Main between MH 33 and MH 35 (Project RR-1):* This project includes lining of approximately 1,380 feet of 24-inch diameter pipeline between MH 33 and MH 35.
- *River Crossing, Gravity Main between MH 65 and MH 66 (Project RR-2):* This project includes lining of approximately 220 feet of 30-inch diameter pipeline between MH 65 and MH 66.
- *River Crossing, Gravity Main between MH 88 and MH 89 (Project RR-3):* This project includes lining of approximately 220 feet of 30-inch diameter pipeline between MH 88 and MH 89.

2.4.2 Estimated Service Life

Given the variance in data for this condition assessment, it is unclear which specific pipe segments are considered to be a higher priority for R&R. However, industry standards for estimated service life can be used to give a general idea of when pipelines should be replaced. The estimated service life is a measure of the number of years expected until a failure may occur and/or when a pipe may need to be rehabilitated or replaced.

A benchmark remaining service life analysis was conducted to understand the age of gravity sewers based on pipe material and installation year. Note that variables such as construction methods, operating environment (soil, slope, pressure, fluid chemistry, etc.), and inspection records were not used as part of this analysis. The assumed service life for RCP and cured-in-place pipe (CIPP) was 80 years and 50 years, respectively. The assumed service life is based on industry reported estimated life expectancies for these materials.

Table 2.4 summarizes the benchmark expected service life of the TRI by length. The benchmark results forecast that 16.7 miles (85 percent) of the TRI have an estimated remaining service life of 36 years or less. The benchmark results did not take into account the condition evaluation described above.

Table 2.4 Benchmark Estimated Remaining Service Life

Estimated Remaining Service Life (Years)	Length (miles)	Percent of TRI (%)
26	1.4	7
36	15.3	78
44	0.4	2
48	0.3	2
50	2.1	11
65	0.1	< 1

The benchmark analysis shows that the collection system will reach its expected service life outside the planning period of this Master Plan. However, if T-TSA were to follow the benchmark analysis beyond the timeframe of this Master Plan, they would see a very disproportional number of R&R projects during certain periods, resulting in significant costs in a short period of time. To prevent this from happening, it is important to flatten the curve with annual renewal projects.

It is recommended that T-TSA begin to address the aging TRI within the 25-year planning period of this Master Plan. However, the exact length of sewer associated with the TRI Renewal Program is unknown at this time since specific R&R projects have not been identified. Therefore, an overall TRI Renewal Program is recommended. The TRI Renewal Program is described below:

- *TRI Renewal Program (Project RR-4):* The TRI Renewal Program addresses sewer infrastructure that is susceptible to failure through R&R projects. The actual R&R projects and phasing should be based on current inspections. The TRI Renewal Program consists of an annual budget to ensure T-TSA has funding to complete R&R projects.

2.5 Recommendations and Conclusions

Repairing and maintaining a wastewater collection system is critical to overall system reliability and performance. To maximize flow through the TRI system and minimize overflows and pipe breakages, proper maintenance and repair of the wastewater collection system is necessary. This includes inspecting, cleaning, repairing, renewing, and replacing sewer pipelines. This also includes utilizing an asset management program to track TRI inspection data, understand the system’s condition over time, and then develop specific pipeline renewal projects.

Costs for the recommended improvements were developed in Volume 2, Chapter 7 - Capital Improvement Plan after they were combined with the recommendations from the other evaluations.

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Tahoe-Truckee Sanitation Agency
Master Sewer Plan

VOLUME 2:
COLLECTION SYSTEM MASTER PLAN
CHAPTER 3:
HISTORIC AND FUTURE FLOWS

FINAL | February 2022

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Chapter 3

HISTORIC AND FUTURE FLOWS

This chapter provides an overview of how historic and future flows were calculated for the Tahoe-Truckee Sanitation Agency's (T-TSA's or Agency's) Master Sewer Plan (Master Plan).

3.1 Wastewater Flow Components

As a way to help the reader understand the wastewater flow components, this section describes and provides definitions of commonly used terminology in the analysis and evaluations conducted as part of this project. In general, wastewater consists of dry weather flow (DWF) and wet weather flow (WWF). DWF (or base flow) is flow generated by routine water usage in the residential, commercial, business, and industrial sectors of the collection system.

The other component of DWF is the contribution of dry weather groundwater infiltration (GWI) into the collection system. Dry weather GWI will enter the sewer system when the relative depth of the groundwater table is higher than the depth of the pipeline, and when the susceptibility of the sanitary sewer pipe allows infiltration through defects such as cracks, misaligned joints, and broken pipelines.

WWF includes storm water inflow, trench infiltration, and GWI. Trench infiltration will enter the sewer system when rainfall wets the soil in a sewer trench, but after the rain event, the trench dries out and trench infiltration no longer enters the sewer system. The storm water inflow and trench infiltration comprise the WWF component termed inflow and infiltration (I/I). Per the T-TSA's Ordinance 2-2015, storm water inflow and other drainage (including drainage from excavations, roofs, foundation drains, or surface or groundwater drains) is not permitted to be discharged to the sanitary sewer system. However, I/I can still occur due to aging infrastructure and needs to be accounted for in the overall wastewater flow. The response in the sewer system to rainfall may be seen immediately (as with inflow) or within hours after the storm (as with infiltration).

The third element of WWF is GWI, which is not specific to a single rainfall event, but rather to the effects on the system over the entire wet weather season. The depth of the groundwater table rising above the pipe invert elevation causes GWI. Sewer pipes within close proximity to a body of water can be greatly influenced by groundwater effects. As the groundwater table fluctuates over the wet weather season, this fluctuation is seen as a mounding effect in flow monitoring data. Figure 3.1 illustrates the various flow components, which are described in detail in the following sections.

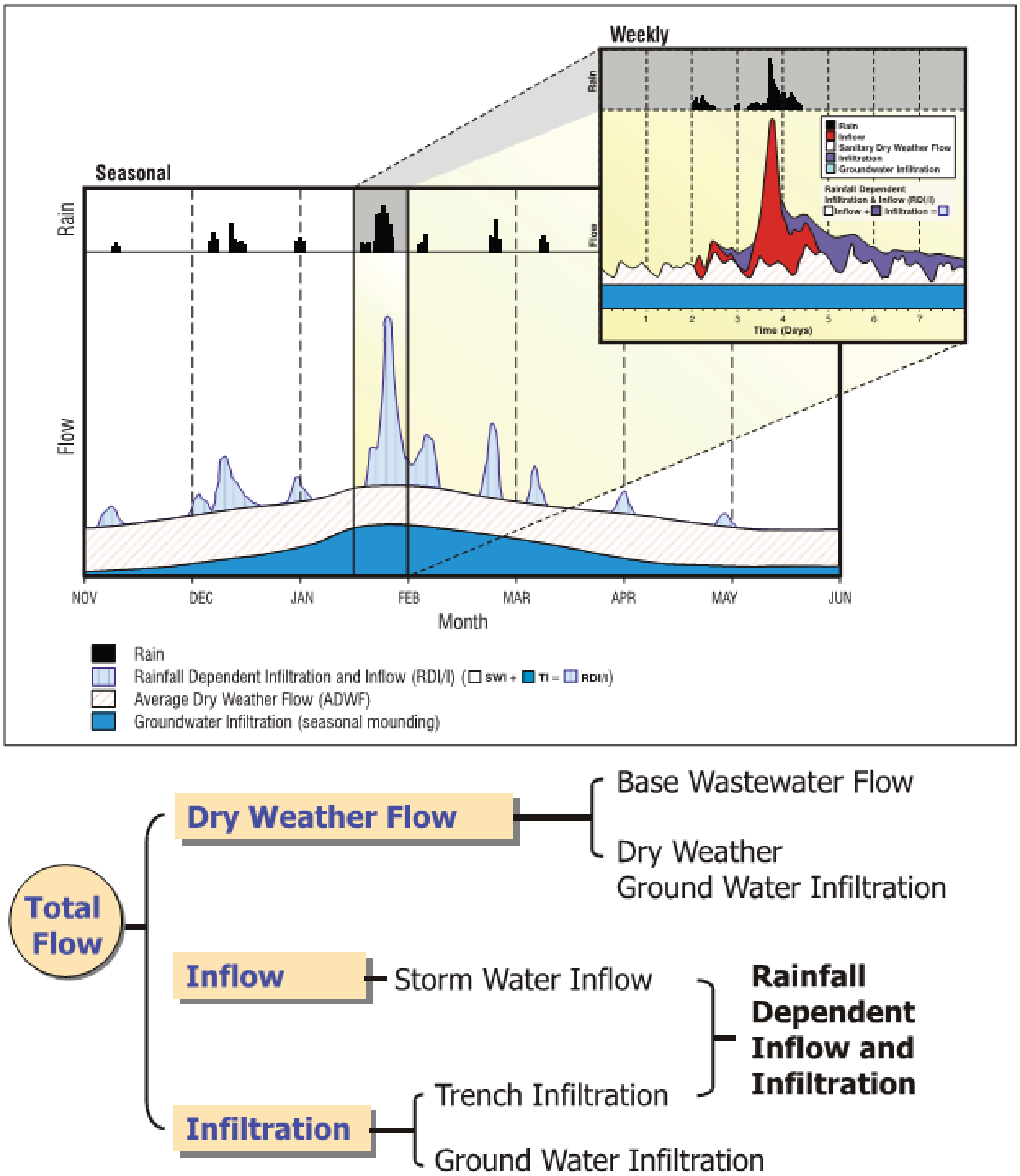

Figure 3.1 Typical Wastewater Flow Components

3.1.1 Base Wastewater Flow

The base wastewater flow (BWF) is the flow generated by the member district customers. The flow has a diurnal pattern that varies depending on the type of use. Commercial and industrial patterns, though they vary depending on the type of use, typically have more consistent higher flows during business hours and lower flows at night. Furthermore, the diurnal flow pattern experienced during a weekend may vary from the diurnal flow experienced during a weekday. For the T-TSA, the average dry weather flow (ADWF) was estimated from the Agency's plant flow data and permanent flow meter data. For the purposes of this Master Plan, the ADWF is defined as the minimum 3-month rolling average flow.

3.1.2 Average Annual Flow

The average annual flow (AAF) is the average flow that occurs on a daily basis throughout the year, including both periods of dry and wet weather conditions.

3.1.3 Average Dry Weather Flow

ADWF is the average flow that occurs on a daily basis during the dry weather season. The ADWF includes the BWF generated by residential, commercial, and industrial users, plus the dry weather GWI component. For the T-TSA, the ADWF is defined as the average of the 7-day rolling average flow from June 21st to September 21st, per T-TSA's Waste Discharge Requirements (WDRs).

3.1.4 Groundwater Infiltration

GWI, one of the components of I/I, is associated with extraneous water entering the sewer system through defects in pipes and manholes. GWI is related to the condition of the sewer pipes and manholes, as well as groundwater levels. GWI may occur throughout the year, although rates are typically higher in the late winter and early spring. Dry weather GWI (or base infiltration) cannot easily be separated from BWF by flow measurement techniques. Therefore, dry weather GWI is typically grouped with BWF.

3.1.5 Infiltration and Inflow

All wastewater collection systems have some I/I, although the characteristics and severity vary by region and individual collection system. Some of the most common sources of I/I are shown in Figure 3.2. Infiltration is defined as storm water flows that enter the sewer system by percolating through the soil and then through defects in pipelines, manholes, and joints. Examples of infiltration entry points are cracks in pipelines, misaligned joints, and root penetration. Inflow is defined as storm water that enters the sewer system via storm drain cross connections, leaky manhole covers, or cleanouts. Examples of inflow entry points are illegal roof drain and downspout connections, leaky manhole covers, and illegal storm drain connections.

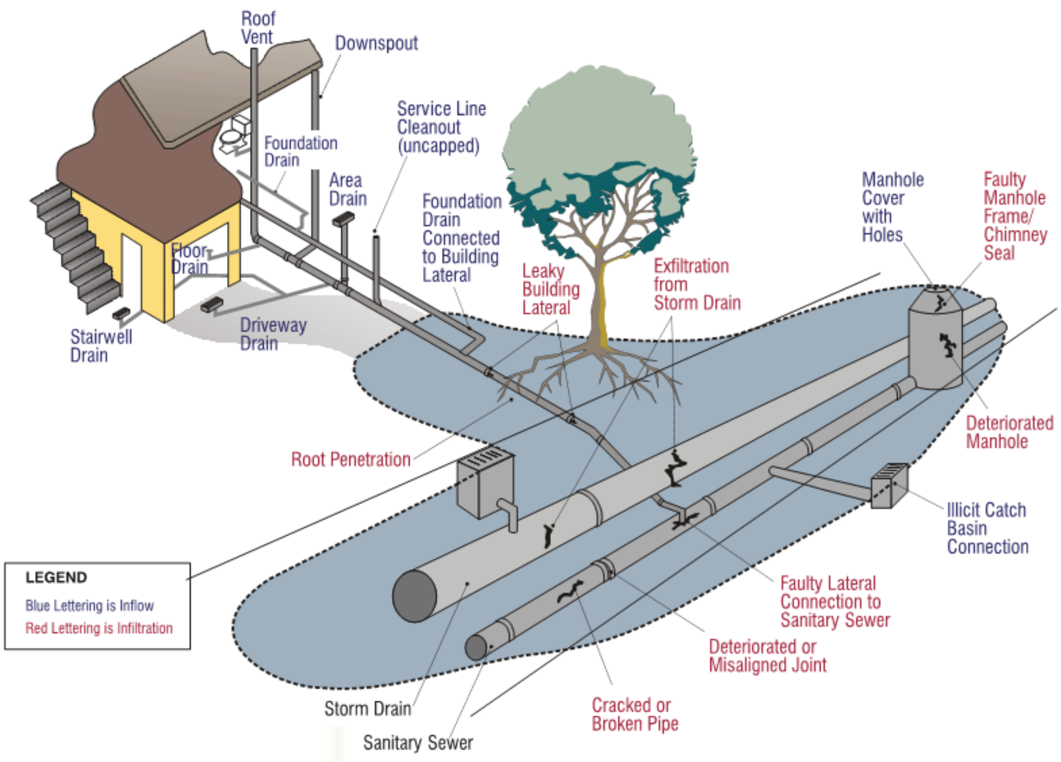

Figure 3.2 Typical Sources of Infiltration and Inflow

The adverse effects of I/I entering the sewer system is that it increases both the flow volume and peak flows, as illustrated in Figure 3.3. If too much I/I enters the sewer system such that the sewer system is operating at or above its capacity, sanitary sewer overflows (SSOs) could occur.

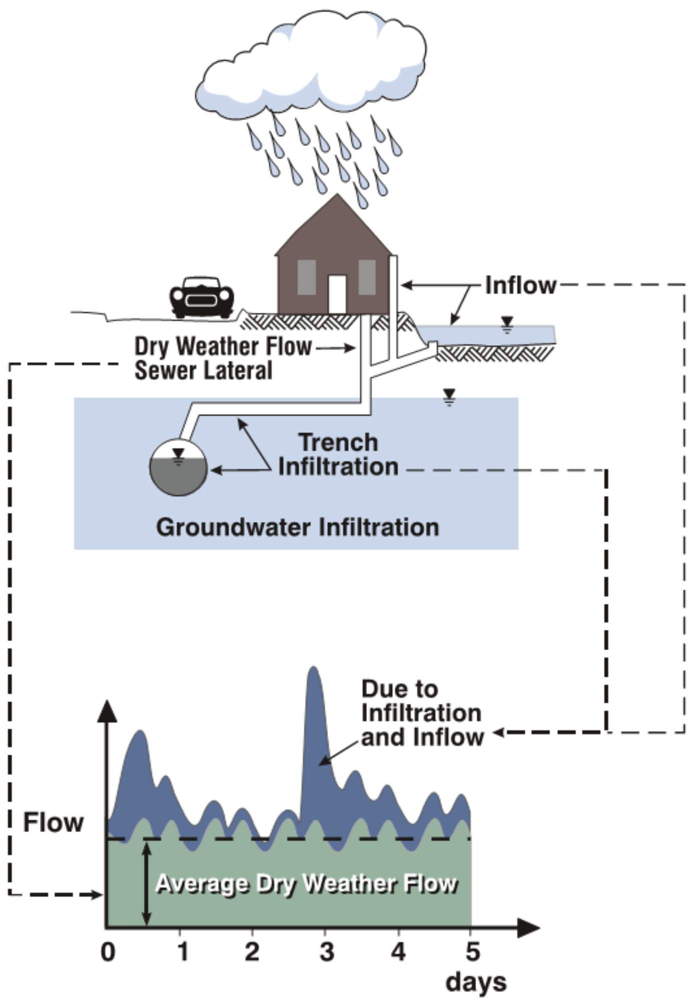

Figure 3.3 Typical Effects of Infiltration and Inflow

3.1.6 Peak Wet Weather Flow (Design Flow)

Peak wet weather flow (PWWF) is the highest observed flow that occurs following a design storm event. Wet weather I/I causes flows in the collection system to increase. PWWF is typically used for designing sewers and lift stations. Therefore, the PWWF and the "Design Flow" are synonymous and will be used interchangeably throughout this report.

3.2 Historic Wastewater Flows

T-TSA monitors flow from seven permanent flow meters on the Truckee River Interceptor (TRI), as well as the influent flow meter at the Water Reclamation Plant (WRP). During significant wet weather events, peak influent flows in excess of 15.4 million gallons per day (mgd) are diverted to the emergency retention basin (ERB) at the WRP and/or the upstream emergency storage ponds on the TRI. Flows that are diverted to the ERB are not tracked on a daily basis; however, flows pumped from the ERB to the Headworks are tracked. In addition, Truckee Sanitary District (TSD) operates several flow meters within their system, some of which were used as a reference as part of this project. Figure 3.4 shows the locations of the permanent flow meters, while Figure 3.5 shows a schematic representation of the flow meters.

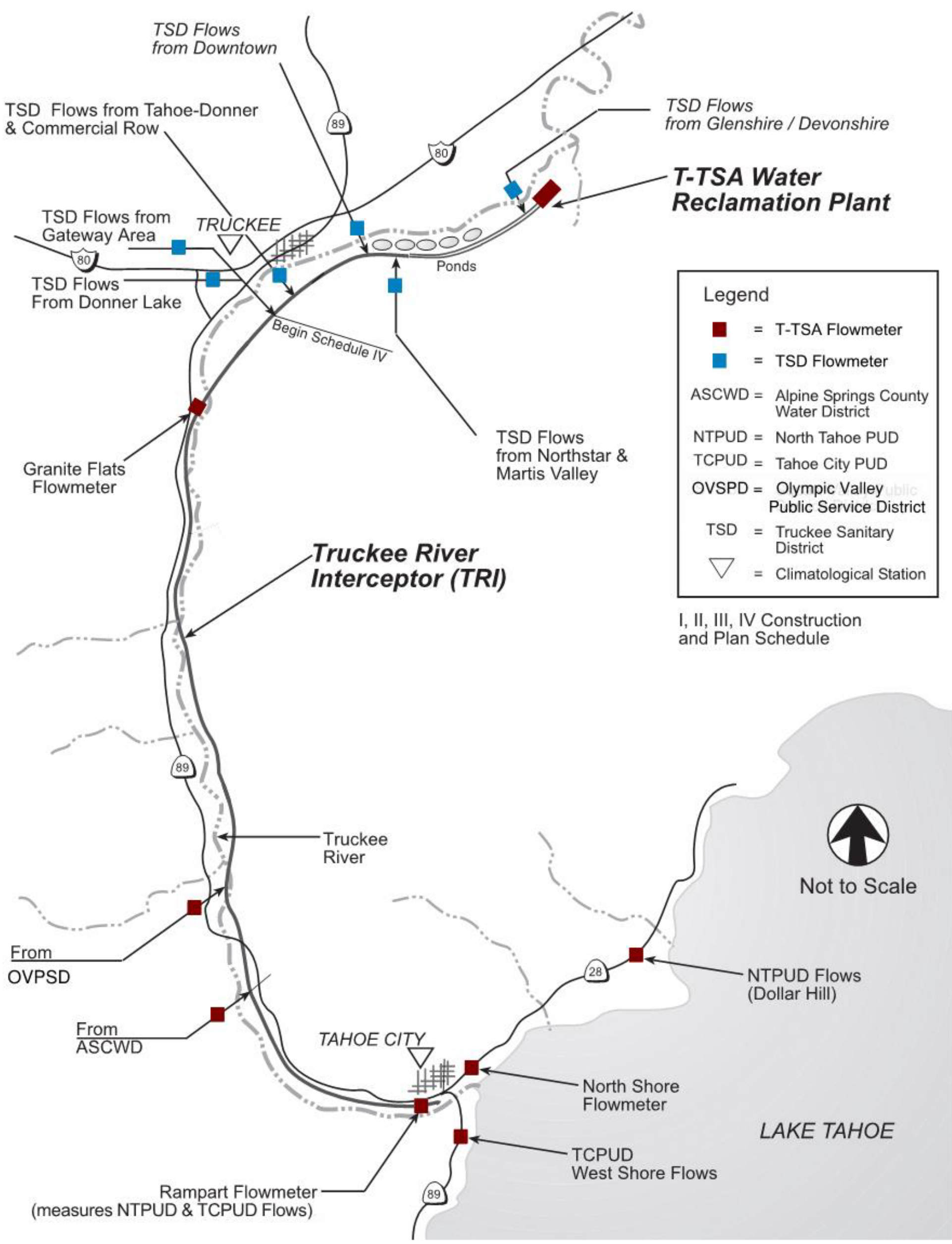

Figure 3.4 Truckee River Interceptor Permanent Flow Meter Locations

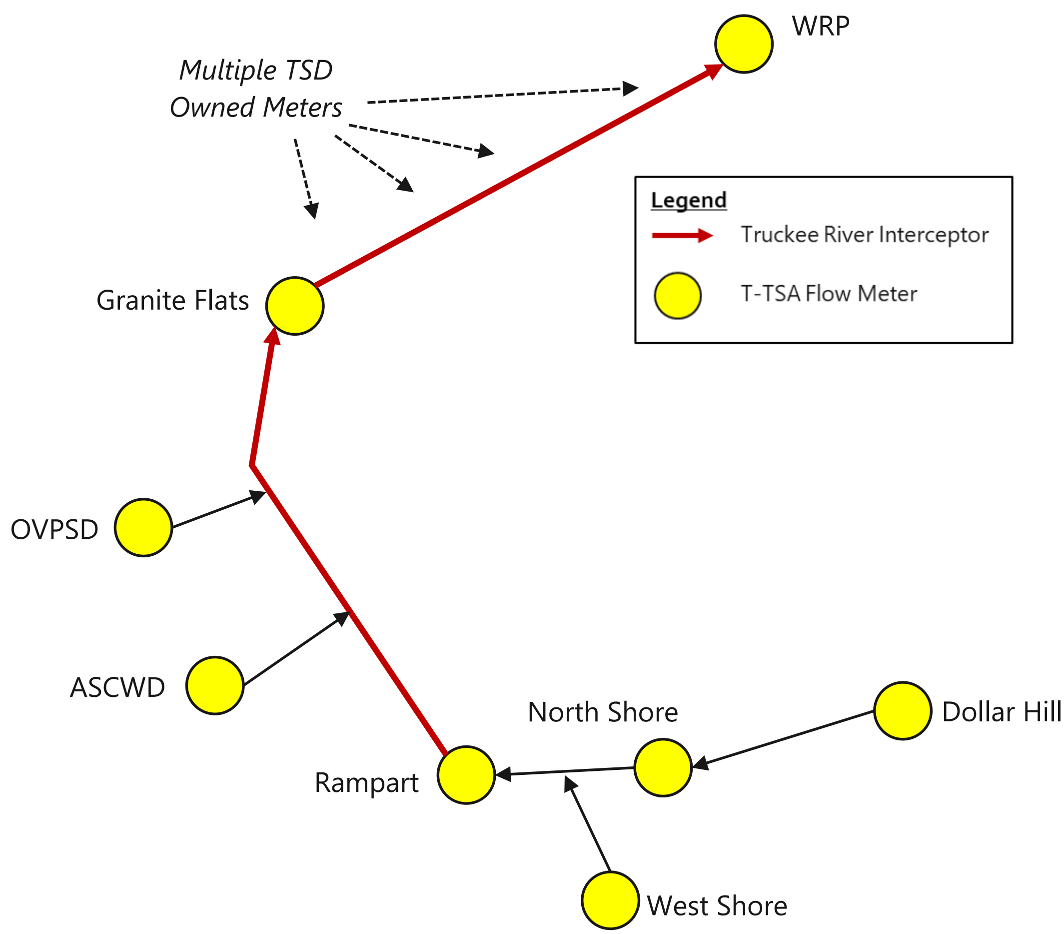

Figure 3.5 Truckee River Interceptor Permanent Flow Meter Schematic

Carollo Engineers, Inc. (Carollo) reviewed the historical permanent flow monitoring data from the years 2014 through 2018. These data were used to establish historical BWF, ADWF, peak DWF, and large historical wet weather events, which were used for wet weather model calibration (see Volume 2, Chapter 4 - Hydraulic Model Development, for additional information). T-TSA tracks data based on the water year; accordingly, the historical flow data were analyzed based on the water year. The latest full year of water year data (water year 2017/18) was used to establish the existing flows within the TRI.

Table 3.1 summarizes the 2017/18 BWF and ADWF for each member agency. As shown in Table 3.1, the existing BWF in the TRI (which is defined for the purposes of this study as the 90-day rolling average minimum flow) is estimated to be approximately 3.34 mgd. The ADWF (which is defined for the purposes of this study as the average of the 7-day rolling average flow between June 21st through September 21st of any year) for 2017/18 was 4.21 mgd. More than half of the flow to the WRP is generated by TSD customers.

As discussed in Volume 2, Chapter 1 - Description of Existing Facilities, T-TSA is designated as the regional entity to transport, treat, and dispose of wastewater from five member districts: North Tahoe Public Utility District (NTPUD), Tahoe City Public Utility District (TCPUD), Alpine Springs County Water District (ASCWD), Olympic Valley Public Service District (OVPSD), and TSD. [Northstar Community Services District (NCSD) also contributes wastewater to T-TSA, via

TSD's sewer collection system, and is not considered a member district, although it is a contributing agency]. Flows from these agencies combine in the TRI and are subsequently treated at the WRP.

Table 3.1 2017/18 BWF and ADWF

Member Agency	2017/18 Base Wastewater Flow(1)(2) (mgd)	2017/18 Average Dry Weather Flow(1)(3) (mgd)
NTPUD	0.621	0.859
TCPUD	0.517	0.807
ASCWD	0.045	0.054
OVPSD	0.154	0.187
TSD (includes NCSD)	2.007	2.305
Total	**3.34**	**4.21**

Notes:
(1) 2017/18 data is representative of the water year.
(2) BWF is the minimum 90 day rolling average flow.
(3) ADWF is the average of the 7 day rolling average flow between June 21st and September 21st.

Given the transient nature of the T-TSA service area, DWFs are typically much higher during holiday weekends. Historical flows for holiday weekends (i.e., high occupancy days) were analyzed to determine peak day flows into the TRI. Table 3.2 summarizes the 2017/18 high occupancy flows (HOF) by agency. As shown in Table 3.2, the two holidays with the highest flows are either New Year's Eve (NYE) or Independence Day (July 4th). DWFs on these days are 1.72 to 2.83 times higher than the typical BWF.

Table 3.2 High Occupancy Flow Summary

Member Agency	2017/18 BWF (mgd)	2017/18 ADWF (mgd)	2017/18 HOF (mgd)					Max. HOF (mgd)	Day of Max. HOF	HOF Peaking Factor (PF)(1)
			NYE 2017	NYE 2018	Memorial Day 2018	July 4, 2018	Labor Day 2018			
NTPUD	0.621	0.859	1.195	1.144	1.100	1.296	1.049	1.296	July 4th	2.08
TCPUD	0.517	0.807	0.986	0.904	0.877	1.203	0.882	1.203	July 4th	2.33
ASCWD	0.045	0.054	0.129	0.113	0.090	0.059	0.064	0.129	NYE	2.83
OVPSD	0.154	0.187	0.392	0.356	0.201	0.165	0.200	0.392	NYE	2.56
TSD	2.007	2.305	3.42	3.34	2.77	3.05	2.77	3.42	NYE	1.72

Notes:
(1) The HOF Peaking Factor is calculated by dividing the maximum HOF by the 2017/18 BWF.
Abbreviation: PF = peaking factor.

As previously mentioned, the WRP hourly influent flow data was also used to identify the largest storm events that occurred since 2017. As shown in Figure 3.6, the most significant wet weather events that have been recorded since 2017 occurred in January/February of 2017, where significant rain-on-snow events occurred. As shown in Figure 3.6, influent flows approached 18 mgd during these events. Note that Figure 3.6 does not show the amount of flow that was diverted to the ERB during these events. Although T-TSA diverted flows to the ERB during some of these significant rain-on-snow events, the WRP does not have the means to measure the amount of flow diversions, and therefore such diversions are not shown in this figure.

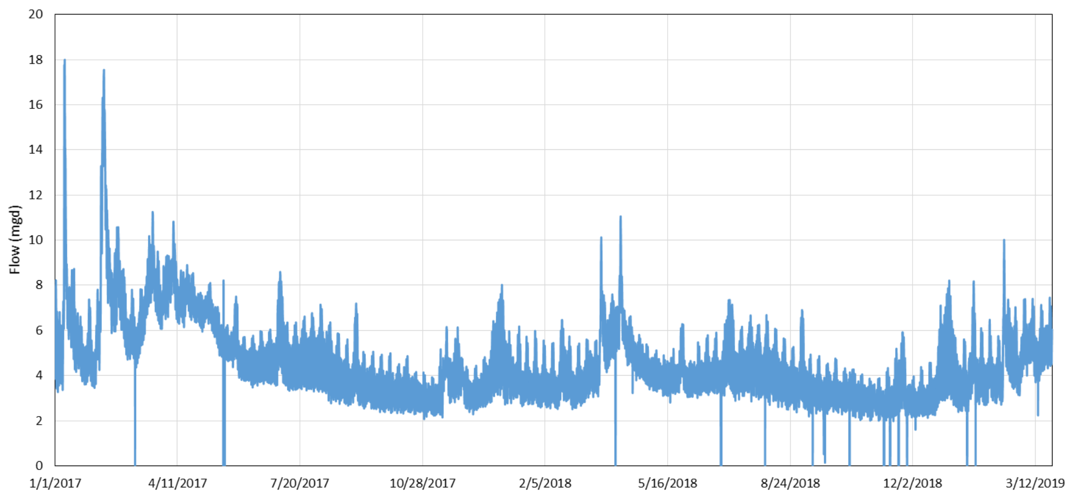

Figure 3.6 Hourly Influent WRP Flows, January 2017-March 2019

3.3 Projected Dry Weather Flows

This section summarizes the methodology used to develop future (year 2045) flow projections for each of the T-TSA contributory agencies. For more detail in how the flow projections were developed, refer to Appendix 3A - Dry Weather Flow Projection Detail.

3.3.1 North Tahoe Public Utility District

To determine how sewer flows from the NTPUD will change in the future, the most recent planning documents for this district were reviewed. These plans included, but were not limited to:

- NTPUD Main Sewer Pump Station Master Plan (Stantec Consulting, Inc., 2009).
- NTPUD Urban Water Management Plan (UWMP) (NTPUD, 2015).
- Linking Tahoe – Regional Transportation Plan and Sustainable Communities Strategy, Horizon Year 2017 – 2040 (Tahoe Regional Planning Agency (TRPA), 2017).
- Sewer Connection Historical Data (T-TSA, 2002-2019).
- Total District Water Production Requirements within the Boundaries of the Public Utility Districts Located in the California Portion of the Lake Tahoe Basin Technical Memorandum (TM) (Kennedy Jenks, 2020).

Within the NTPUD service area, full buildout has not yet been achieved. Therefore, the growth rate for this service area is needed to calculate future sewer flows. Growth rate assumptions were reviewed and compared for the various NTPUD planning documents, as shown in Table 3.3.

The selected growth rate of 0.77 percent per year was provided in the NTPUD 2015 UWMP, and appeared to be a slightly conservative, but reasonable growth rate as compared to the historical growth rate of sewer connections within the NTPUD service area.

Table 3.3 NTPUD Growth Rate Comparison

Planning Document	Average Annual Growth
NTPUD Main Sewer Pump Station Master Plan (Stantec Consulting, Inc., 2009)	0.44%
NTPUD UWMP (NTPUD, 2015)	**0.77%**
Linking Tahoe – Regional Transportation Plan and Sustainable Communities Strategy, Horizon Year 2017 – 2040 (TRPA, 2017)	3.70 %
Sewer Connection Historical Data (T-TSA, 2002-2019)	0.20% (12 SFRs)

Notes:
(1) Text in **bold** indicates selected document and value.
Abbreviations: SFRs = single-family residence/residential.

The Total District Water Production Requirements within the Boundaries of the Public Utility Districts Located in the California Portion of the Lake Tahoe Basin TM (Kennedy Jenks, 2020) provided existing and buildout water demand estimates for the major public utility districts on the California side of the Lake Tahoe Basin. These projections were used to develop a buildout wastewater flow projection by applying a return-to-sewer ratio to the future demand projections for NTPUD. To develop the return-to-sewer ratio, the 2018 baseline water production requirements (per the 2020 Kennedy Jenks TM) were compared to the 2018 BWF for NTPUD, as measured by the Dollar Hill sewer flume. The ratio of the 2018 BWF to the baseline water production yielded a return-to-sewer ratio of 0.33.

The buildout BWF for NTPUD was then calculated by multiplying the return-to-sewer ratio of 0.33 by the buildout water demand (2.53 mgd) as documented in the Total District Water Production Requirements within the Boundaries of the Public Utility Districts Located in the California Portion of the Lake Tahoe Basin TM (Kennedy Jenks, 2020). This yielded a buildout BWF of 0.85 mgd.

The 2045 BWF for NTPUD was calculated by applying a 0.77 percent per year growth to the existing BWF for NTPUD (0.62 mgd). This yielded a 2045 BWF of 0.76 mgd, which means that it is expected that buildout for NTPUD would occur after 2045. 2045 HOF for NTPUD was estimated by applying the High Occupancy PF of 2.08 cited in Table 3.2 to the projected 2045 BWF. This yielded a projected 2045 HOF for NTPUD of 1.59 mgd.

The existing ADWF (0.86 mgd) was calculated by averaging the 7-day running average between June 21st and September 21st, as measured by the Dollar Hill sewer flume. An ADWF:BWF peaking factor of 1.38 was calculated by dividing the 2017/18 ADWF by the 2017/18 BWF. This peaking factor was then applied to the BWF to project future ADWF. The 2045 ADWF was determined to be 1.06 mgd and the buildout ADWF was calculated to be 1.18 mgd.

Figure 3.7 shows the projected DWFs for NTPUD.

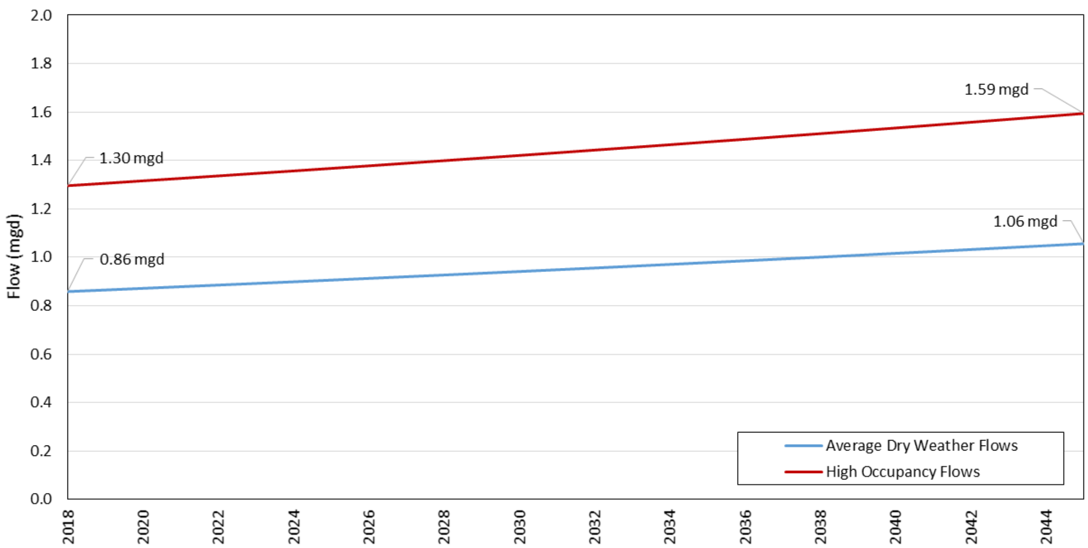

Figure 3.7 NTPUD Dry Weather Flow Projections

3.3.2 Tahoe City Public Utility District

To determine how sewer flows from TCPUD will change in the future, the most recent planning documents for this district were reviewed. These plans included, but were not limited to:

- Final Draft Preliminary Design Report (PDR) for West Lake Tahoe Regional Water Treatment Plant (Kennedy/Jenks Consultants with Auerbach Engineering Corp., 2014).
- TCPUD 2015 UWMP (TCPUD, 2015).
- Linking Tahoe – Regional Transportation Plan and Sustainable Communities Strategy, Horizon Year 2017 – 2040 (TRPA, 2017).
- Sewer Connection Historical Data (T-TSA, 2002-2019).
- Total District Water Production Requirements within the Boundaries of the Public Utility Districts Located in the California Portion of the Lake Tahoe Basin TM (Kennedy Jenks, 2020).

Within the TCPUD service area, full buildout has not yet been achieved. Therefore, the growth rate for this service area is needed to calculate future sewer flows. Growth rate assumptions were reviewed and compared for the various TCPUD planning documents, as shown in Table 3.4. The selected growth rate of 0.25 percent per year was provided in the TCPUD 2015 UWMP.

Table 3.4 TCPUD Growth Rate Comparison

Planning Document	Average Annual Growth
Final Draft PDR for West Lake Tahoe Regional Water Treatment Plant (Kennedy/Jenks Consultants with Auerbach Engineering Corp., 2014)	0.40%
TCPUD UWMP (TCPUD, 2015)	**0.25%**
Linking Tahoe – Regional Transportation Plan and Sustainable Communities Strategy, Horizon Year 2017 – 2040 (TRPA, 2017)	3.70%
Sewer Connection Historical Data (T-TSA, 2002-2019)	0.31% (24 SFRs)

Notes:
(1) Text in **bold** indicates selected document and value.

The Total District Water Production Requirements within the Boundaries of the Public Utility Districts Located in the California Portion of the Lake Tahoe Basin TM (Kennedy Jenks, 2020) provided existing and buildout water demand estimates for the major public utility districts on the California side of the Lake Tahoe Basin. These projections were used to develop a buildout wastewater flow projection by applying a return-to-sewer ratio to the future demand projections for TCPUD. To develop the return-to-sewer ratio, the 2018 baseline water production requirements (per the 2020 Kennedy Jenks TM) were compared to the 2018 BWF for TCPUD, as measured by the Rampart sewer flume (minus the measured flow for NTPUD from the Dollar Hill sewer flume). The ratio of the 2018 BWF to the baseline water production yielded a return-to-sewer ratio of 0.20.

The buildout BWF for TCPUD was then calculated by multiplying the return-to-sewer ratio of 0.20 by the buildout water demand (3.43 mgd) as documented in the Total District Water Production Requirements within the Boundaries of the Public Utility Districts Located in the California Portion of the Lake Tahoe Basin TM (Kennedy Jenks, 2020). This yielded a buildout BWF of 0.67 mgd.

The 2045 BWF for TCPUD was calculated by applying a 0.25 percent per year growth rate to the existing BWF for TCPUD (0.52 mgd). This yielded a 2045 BWF of 0.55 mgd, which means that it is expected that buildout for TCPUD would occur after 2045. 2045 HOF for TCPUD was estimated by applying the High Occupancy PF of 2.33 cited in Table 3.2 to the projected 2045 BWF. This yielded a projected 2045 HOF for TCPUD of 1.29 mgd.

The existing ADWF (0.81 mgd) was calculated by averaging the 7-day running average between June 21st and September 21st, as measured by the Rampart sewer flume (minus the measured flow for NTPUD from the Dollar Hill sewer flume). An ADWF:BWF peaking factor of 1.56 was calculated by dividing the 2017/18 ADWF by the 2017/18 BWF. This peaking factor was then applied to the BWF to project future ADWF. The 2045 ADWF was determined to be 0.86 mgd and the buildout ADWF was calculated to be 1.05 mgd.

Figure 3.8 shows the projected DWFs for TCPUD.

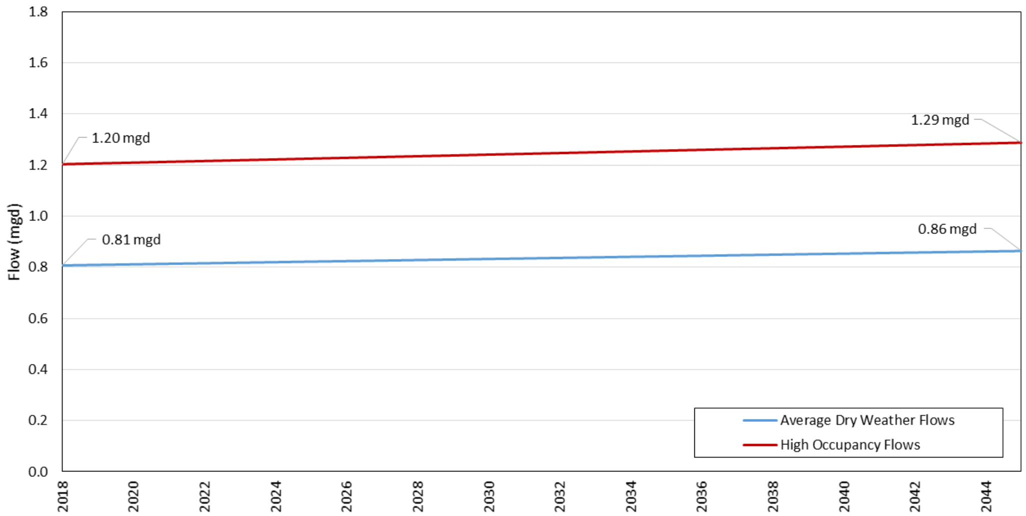

Figure 3.8 TCPUD Dry Weather Flow Projections

3.3.3 Alpine Springs County Water District

To determine how sewer flows from ASCWD will change in the future, the most recent planning documents for this district were reviewed. These plans included, but were not limited to:

- Recommended Long Range Water and Sewer Master Plan (Lumos and Associates, Inc., 2006).
- Sewer Connection Historical Data (T-TSA, 2002-2019).

Within the ASCWD service area, full buildout has not yet been achieved. Therefore, the growth rate for this service area is needed to calculate future sewer flows. Growth rate assumptions were reviewed and compared for the available ASCWD planning documents, as shown in Table 3.5. The selected growth rate of 0.34 percent per year was based on the historical sewer connection data.

Table 3.5 ASCWD Growth Rate Comparison

Planning Document	Average Annual Growth
Recommended Long Range Water and Sewer Master Plan (Lumos and Associates, Inc., 2006) - Assumes buildout in 2026; 0 percent growth after that date	0.71% (10 SFRs)
Sewer Connection Historical Data (T-TSA, 2002-2019)	**0.34% (2 SFRs)**

Notes:
(1) Text in **bold** indicates selected document and value.

Future flows for ASCWD include minor growth (roughly 2 SFR units per year) from the current service area. Additionally, two planned developments are expected to contribute flow in the future. These two developments are the White Wolf Subdivision and the Alpine Sierra

Subdivision. Carollo consulted with ASCWD staff to understand the potential timing of these developments. Based on these discussions, the following growth rate assumptions were used:

- Alpine Sierra: This project was assumed to start in year 2025 and to be completely built out by 2040. A total of 52 SFR units are expected, and 3.25 units were expected to be connected per year during those time periods.
- White Wolf: This project includes a total of 58 SFR units. This subdivision is assumed to begin connecting homes in 2035 and to be built out by 2040 (or roughly 10 SFRs per year of growth).

By 2045, it is projected that the BWF for ASCWD will increase to 0.056 mgd (compared to the existing BWF of 0.045 mgd), and the HOF is projected to increase to 0.16 mgd (compared to the existing HOF of 0.13 mgd). Continuing to project flows for ASCWD yielded a buildout BWF of 0.062 mgd.

The existing ADWF (0.054 mgd) was calculated by averaging the 7-day running average between June 21st and September 21st, as measured by the Alpine sewer flume. An ADWF:BWF peaking factor of 1.19 was calculated by dividing the 2017/18 ADWF by the 2017/18 BWF. This peaking factor was then applied to the BWF to project future ADWF. The 2045 ADWF was determined to be 0.067 mgd and the buildout ADWF was calculated to be 0.074 mgd.

Figure 3.9 shows the projected DWFs for ASCWD.

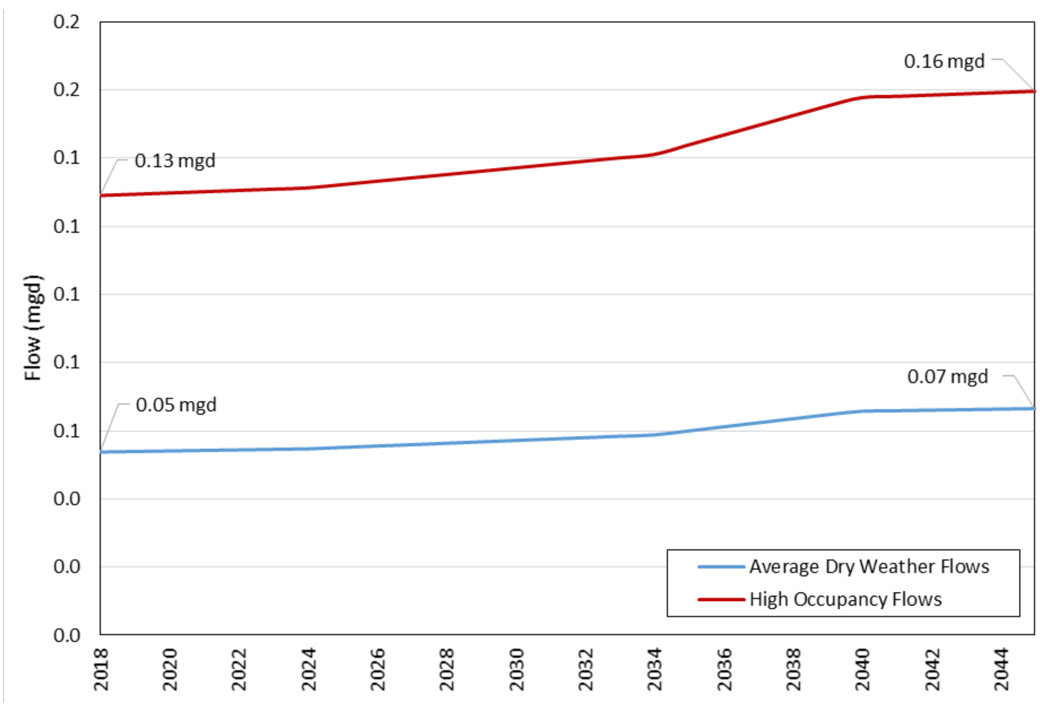

Figure 3.9 ASCWD Dry Weather Flow Projections

3.3.4 Olympic Valley Public Service District

To determine how sewer flows from OVPSD will change in the future, the most recent planning documents for this district were reviewed. These plans included, but were not limited to:

- Village at Squaw Valley Sewer Capacity Analysis TM (Farr West Engineering, 2014).
- Village at Squaw Valley Water Supply Assessment (Farr West Engineering, Hydro Metrics WRI and Todd Engineering, 2015).
- Sewer Connection Historical Data (T-TSA, 2002-2019).
- Sewer Connection Historical Data (OVPSD, 2000-2020).

Within the OVPSD service area, full buildout has not yet been achieved. Therefore, the growth rate for this service area is needed to calculate future sewer flows. Growth rate assumptions were reviewed and compared for the available OVPSD planning documents, as shown in Table 3.6. The selected growth rate of 0.23 percent per year for general development in the OVPSD service area was based on the historical sewer connection data.

Table 3.6 OVPSD Growth Rate Comparison

Planning Document	Development Type	Average Annual Growth
Village at Squaw Valley Sewer Capacity Analysis TM (Farr West Engineering, 2014)	**RSC2**	**varies 17 SFRs for RSC2**
Village at Squaw Valley Water Supply Assessment (Farr West Engineering, Hydro Metrics WRI and Todd Engineering, 2015)	**VSVSP**	**varies 2 – 7% for VSVSP**
Sewer Connection Historical Data (T-TSA, 2002-2019)	**general**	**0.23% (5 SFRs)**
Sewer Connection Historical Data (OVPSD, 2000-2019)		9 SFRs

Notes:
(1) Text in **bold** indicates selected document and value.

Future flows for OVPSD include growth associated with General Plan development within the current service area, as well as future development associated with the Village at Squaw Valley Specific Plan (VSVSP) and the Resort at Squaw Creek Phase 2 (RSC2). Carollo consulted with OVPSD staff to understand the potential timing of these developments. Based on these discussions, the following growth rate assumptions were used:

- General Plan Development: Future growth within the current service area includes three components: SFR growth, "foreseeable" multifamily residential (MFR) and commercial growth, and longer term MFR and commercial growth. Single-family residential growth was assumed to occur at a rate of approximately 5 SFRs per year. The "foreseeable" MFR and commercial growth was established based on specific developments which are expected to occur in the relative near term and are assumed to be constructed between 2025 and 2035. The longer term MFR and commercial growth is associated with specific projects that are not expected to develop in the near term, and are phased between 2030 and 2045. In total, the "foreseeable" and longer term MFR and commercial development consists of 426 condos and 195,000 square feet (sq ft) of commercial developments.

- Village at Squaw Valley: This project was assumed to start in year 2021 and to be completely built out by 2045. A total of 900 condos and 298,000 sq ft of commercial development are expected. Assumed annual growth rates for this project range from 2 percent to 7 percent, per the "Village at Squaw Valley Water Supply Assessment" planning document.
- Resort at Squaw Creek Phase 2: This project includes a total of 263 condos. This project is expected to be developed between the years 2020 and 2036, and has an assumed growth rate of 17 units per year.

By 2045, it is projected that the BWF for OVPSD will increase to 0.433 mgd (compared to the existing BWF of 0.154 mgd), and the HOF is projected to increase to 1.102 mgd (compared to the existing HOF of 0.392 mgd). Continuing to project flows for OVPSD yields a buildout BWF of 0.434 mgd.

The existing ADWF (0.187 mgd) was calculated by averaging the 7-day running average between June 21st and September 21st, as measured by the Olympic Valley sewer flowmeter. An ADWF:BWF peaking factor of 1.21 was calculated by dividing the 2017/18 ADWF by the 2017/18 BWF. This peaking factor was then applied to the BWF to project future ADWF. The 2045 ADWF was determined to be 0.526 mgd and the buildout ADWF was calculated to be 0.527 mgd.

Figure 3.10 shows the projected DWFs for OVPSD.

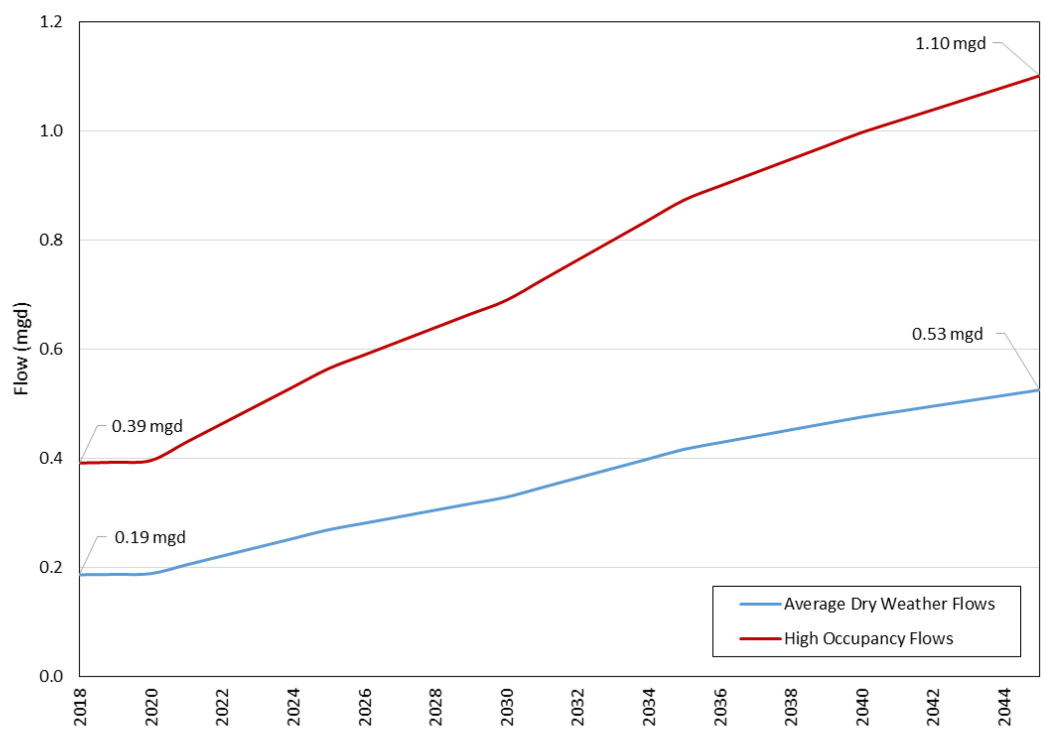

Figure 3.10 OVPSD Dry Weather Flow Projections

3.3.5 Truckee Sanitary District

To determine how sewer flows from TSD will change in the future, the most recent planning documents for this district were reviewed. These plans included, but were not limited to:

- Truckee Water System 2015 UWMP (Truckee Donner Public Utility District (TDPUD), 2016).
- Town of Truckee 2040 General Plan (Town of Truckee, 2019).
- Sewer Connection Historical Data (TSD, 2002-2019).
- Sewer Connection Historical Data (T-TSA, 2002-2019).
- TSD Sewer System Hydraulic Model Update TM (Carollo, 2019).

Within the TSD service area, full buildout has not yet been achieved. Therefore, the growth rate for this service area is needed to calculate future sewer flows. Growth rate assumptions were reviewed and compared for the various TSD planning documents, as shown in Table 3.7. The selected growth rate of 300 SFRs per year was provided based on historical connection data from TSD.

Table 3.7 TSD Growth Rate Comparison

Planning Document	Average Annual Growth
Truckee Water System 2015 UWMP (TDPUD, 2016)	2.08%
Town of Truckee 2040 General Plan (Town of Truckee, 2019)	0.39%-1.06%
Sewer Connection Historical Data (TSD, 2002-2019)	**~1.95% (300 SFRs)**
Sewer Connection Historical Data (T-TSA, 2002-2019)	1.80% (203 SFRs)

Notes:
(1) Text in **bold** indicates selected document and value.

The buildout HOF and BWF for TSD was provided by the TSD Sewer System Hydraulic Model Update TM. Based on this document, the buildout HOF of the TSD service area is estimated to be 5.53 mgd.

The 2045 BWF for TSD was calculated by applying the 300 SFR per year growth rate to the existing BWF for TSD (1.73 mgd). This yielded a 2045 BWF of 2.82 mgd, which means that it is expected that buildout for TSD would occur after 2045. 2045 HOF for TSD was estimated by applying the High Occupancy PF of 1.72 cited in Table 3.2 to the projected 2045 BWF. This yielded a projected HOF for TSD of 4.84 mgd.

The existing ADWF (1.99 mgd) was calculated by averaging the 7-day running average between June 21st and September 21st. An ADWF:BWF peaking factor of 1.15 was calculated by dividing the 2017/18 ADWF by the 2017/18 BWF. This peaking factor was then applied to the BWF to project future ADWF. The 2045 ADWF was determined to be 3.24 mgd and the buildout ADWF was calculated to be 3.70 mgd.

Figure 3.11 shows the projected DWFs for TSD.

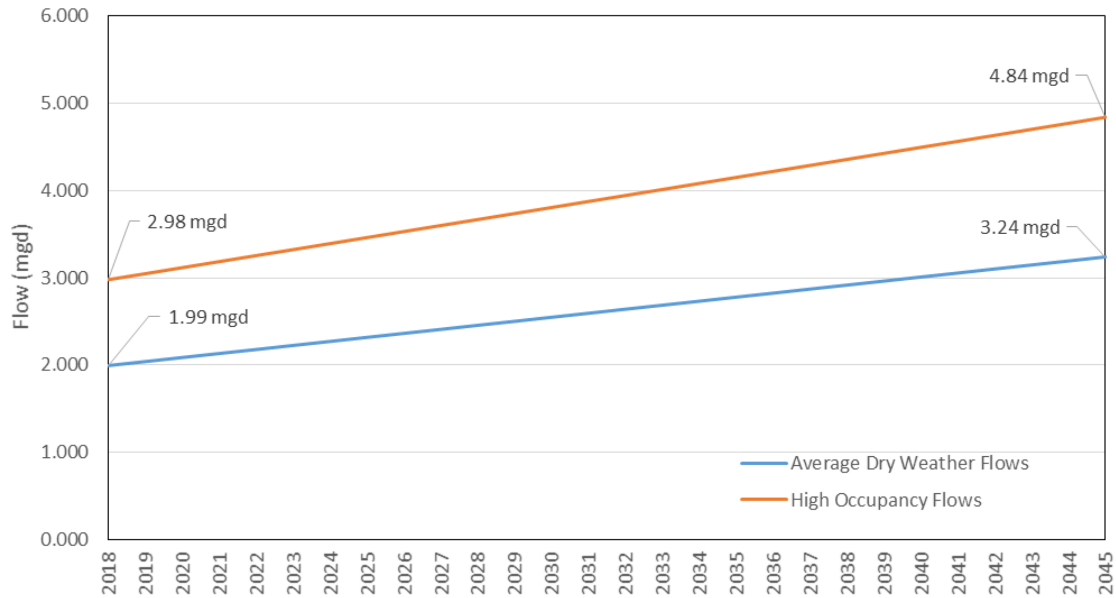

Figure 3.11 TSD Dry Weather Flow Projections

3.3.6 Northstar Community Services District

To determine how sewer flows from NCSD will change in the future, the most recent planning documents for this district were reviewed. These plans included, but were not limited to:

- Northstar Water Model Project TM (Auerbach Engineering Corp., 2004).
- NCSD Sewer Capacity Analysis (ECO:LOGIC Engineering, 2005).
- NCSD Wastewater Collection System Master Plan (ECO:LOGIC Engineering, 2008).
- NCSD Sewer Capacity Analysis – Martis Valley West (Farr West Engineering, 2015).
- Martis Valley West Parcel Project Water Supply Assessment (Stantec, 2015).
- Sewer Connection Historical Data (NCSD, 2018).
- Sewer Connection Historical Data (T-TSA, 2002-2019).

Within the NCSD service area, full buildout has not yet been achieved. Therefore, the growth rate for this service area is needed to calculate future sewer flows. Growth rate assumptions were reviewed and compared for the various NCSD planning documents, as shown in Table 3.8. The selected growth rate of 4 SFRs per year for general development in the NCSD service area was provided based on historical connection data from NCSD.

Table 3.8 NCSD Growth Rate Comparison

Planning Document	Development Type	Average Annual Growth
Northstar Water Model Project TM (Auerbach Engineering Corp., 2004)		7.12%
NCSD Sewer Capacity Analysis (ECO:LOGIC Engineering, 2005)	**Martis Valley West**	**19 SFRs 2,725 sq ft**
NCSD Wastewater Collection System Master Plan (ECO:LOGIC Engineering, 2008)		2.15%
NCSD Sewer Capacity Analysis – Martis Valley West (Farr West Engineering, 2015)		19 SFRs
Martis Valley West Parcel Project – Water Supply Assessment (Stantec, 2015)		19 SFRs
Sewer Connection Historical Data (NCSD, 2018)	**general**	**4 SFRs**
Sewer Connection Historical Data (T-TSA, 2002-2019)		2.18%

Notes:
(1) Text in **bold** indicates selected document and value.

Future flows for NCSD include single-family residential growth within the existing service area, as well as future development associated with the Martis Valley West Project. The Martis Valley West Project includes 375 SFRs, 385 condos and cabins, and 54,500 sq ft of commercial development, which is assumed to occur between 2026 and 2045. For the Martis Valley West Project, higher growth rates were assumed, as similar developments in the area have been constructed in short time frames. Annual growth rates of 19 dwelling units per year and 2,725 sq ft of commercial floor space per year were assumed for the Martis Valley West project.

The 2045 BWF for NCSD was calculated to be 0.47 mgd (compared to the existing BWF of 0.28 mgd). 2045 HOF for NCSD was estimated by applying the High Occupancy PF of 1.72 cited in Table 3.2 to the projected 2045 BWF. This yielded a projected HOF for NCSD of 0.81 mgd.

The buildout HOF and BWF for TSD, which includes NCSD, was provided by the TSD Sewer System Hydraulic Model Update TM. Based on this document, the buildout HOF of the NCSD service area is estimated to be 1.02 mgd, which is expected to occur after 2045.

The existing ADWF (0.32 mgd) was calculated by averaging the 7-day running average between June 21st and September 21st. An ADWF:BWF peaking factor of 1.15 was calculated by dividing the 2017/18 ADWF by the 2017/18 BWF. This peaking factor was then applied to the BWF to project future ADWF. The 2045 ADWF was determined to be 0.54 mgd and the buildout ADWF was calculated to be 0.67 mgd.

Figure 3.12 shows the projected DWFs for NCSD.

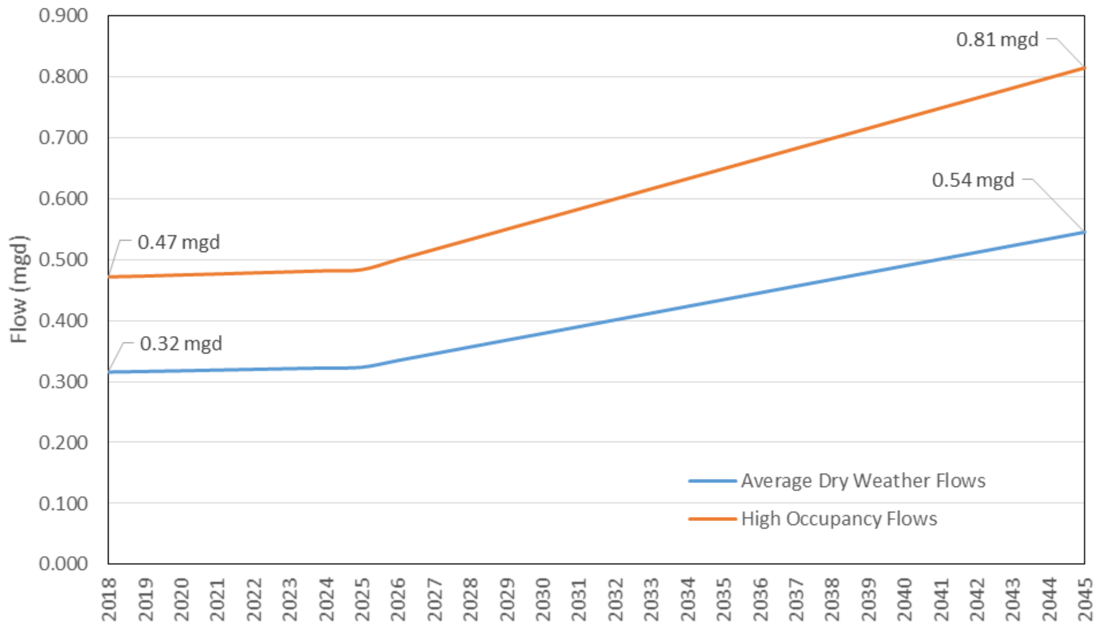

Figure 3.12 NCSD Dry Weather Flow Projections

3.3.7 Dry Weather Flow Projection Summary

Table 3.9 summarizes the total projected DWFs. As shown in Table 3.9, the total flow within the T-TSA service area is projected to increase to 6.30 mgd and 9.77 mgd for ADWF and HOF conditions, respectively. This represents roughly a 49 and 52 percent increase above existing flows for ADWF and HOF, respectively. Figure 3.13 shows the projected DWFs in a graphical format.

Table 3.9 T-TSA Dry Weather Flow Projection Summary

Member Agency	BWF (mgd)		ADWF (mgd)		HOF (mgd)	
	2018	2045	2018	2045	2018	2045
North Tahoe PUD	0.62	0.76	0.86	1.06	1.30	1.59
Tahoe City PUD	0.52	0.55	0.81	0.86	1.20	1.29
Alpine Springs CWD	0.05	0.06	0.05	0.07	0.13	0.16
Olympic Valley PSD	0.15	0.43	0.19	0.53	0.39	1.10
Truckee SD	1.73	2.83	1.99	3.24	2.95	4.81
Northstar CSD	0.28	0.48	0.32	0.54	0.47	0.81
Total	**3.34**	**5.11**	**4.22**	**6.30**	**6.44**	**9.77**

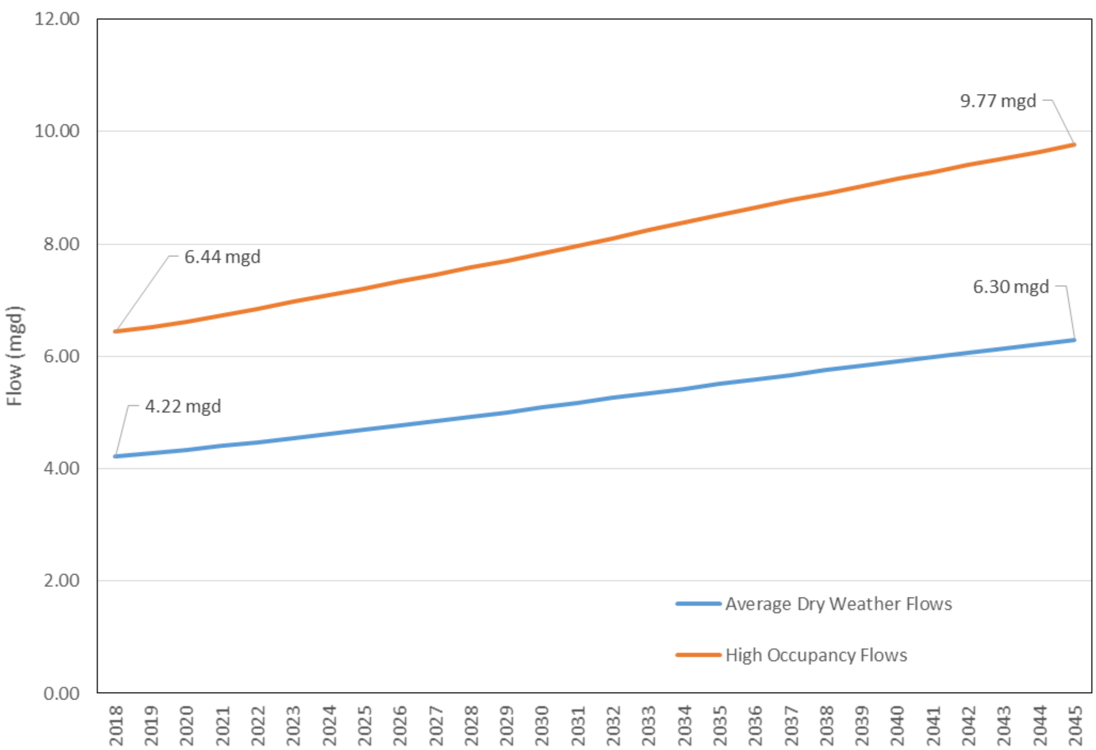

Figure 3.13 T-TSA Dry Weather Flow Projection Summary

3.4 Existing and Future Peak Wet Weather Flow Projections

This section summarizes the methodology used to develop the estimated existing and future PWWF for the T-TSA Service Area.

3.4.1 Existing Peak Wet Weather Flow

The existing PWWF was estimated by routing a design storm through the TRI hydraulic model, which was developed and calibrated as documented in Chapter 4 of this Volume.

3.4.1.1 Design Storms

Design storms are rainfall events used to analyze the performance of a collection system under extreme wet weather events. The first step in the development of the design storm is to define its recurrence interval and rainfall duration. The recurrence interval is based on the probability that a given rainfall event will occur or be exceeded in any given year. For example, a "100-year storm" means there is a 1 in 100 chance that a storm as large, or larger, than this event will occur at a specific location in any year. Duration is the length of time in which the rainfall occurs and is typically in hours.

Typical design storms for wastewater collection systems in California range from 5-year events to 25-year events (typically with 24-hour durations). The National Oceanic and Atmospheric Association (NOAA) Atlas 14 serves as the industry standard for determining total rainfall depth at specified frequencies and durations in California. For the purposes of this study, a 10-year, 24-hour design event was selected. It should be noted that the hydraulic model wet weather parameters were calibrated to mimic storm event responses to "rain-on-snow" events, which have historically produced the highest flows at the WRP. Therefore, the TRI hydraulic model is designed to mimic the effect of a 10-year, 24-hour rainfall event occurring at a time where a significant snow pack is on the ground.

Due to the varied terrain of the T-TSA service area, several design storms were developed for the different member agencies. The 10-year rainfall amounts for the various areas are listed in Table 3.10. As shown in Table 3.10, the 10-year, 24-hour rainfall event volumes range from 4.09 inches to 7.03 inches within the T-TSA service area.

Table 3.10 10-Year, 24-Hour Design Storm Volume

Agency Name	10-Yr, 24-Hr Rainfall Volume (inches)
TCPUD/NTPUD	4.85
ASCWD/OVPSD	7.03
TSD - Donner Lake Area	5.61
TSD - Tahoe Donner Area	4.96
TSD - Martis Valley/Glenshire Areas & NCSD	4.09

Once the 10-year, 24-hour rainfall event volumes were established, the hourly rainfall distribution was determined. The design storm rainfall distribution was based on the early January 2017 rainfall event distribution, which was the most significant rain-on-snow event that occurred in the area in recent years. The design storm distributions are shown in Figure 3.14.

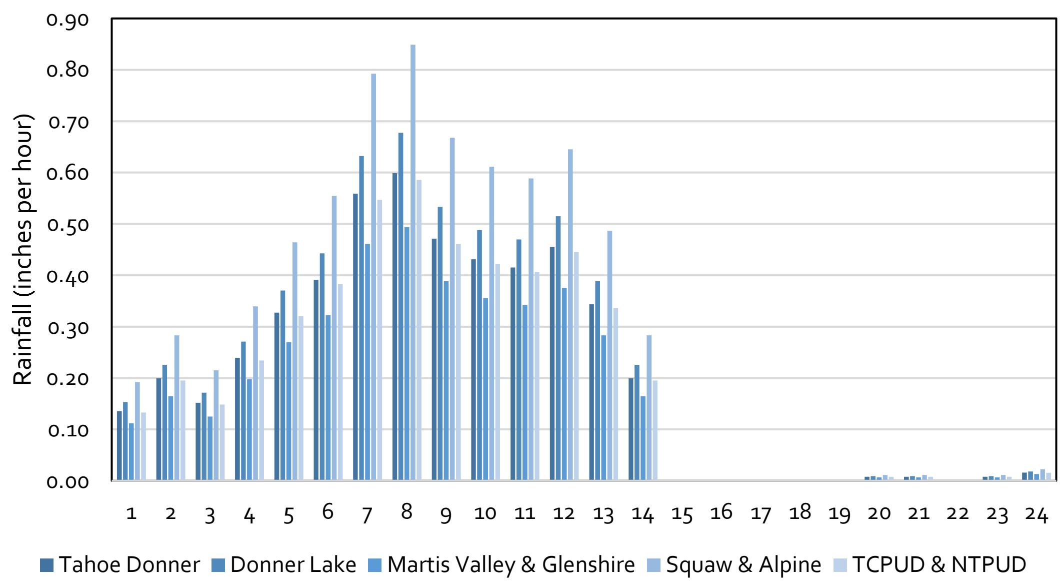

Figure 3.14 10-Year, 24-Hour Design Storms

3.4.1.2 Existing Peak Wet Weather Flow

The existing PWWF was developed by routing the 10-year, 24-hour events shown in Figure 3.14 through the hydraulic model. It should be noted that the design storm was routed on top of HOFs, which would provide the most conservative estimate of the PWWF; however, it is reasonable to assume that the design storm would occur on a high occupancy day like NYE or New Year's Day, as major rain-on-snow events have occurred on New Year's in the past. As shown in Figure 3.15, the existing PWWF at the WRP is estimated to be approximately 21.9 mgd, which equates to a PWWF/HOF PF of 3.4.

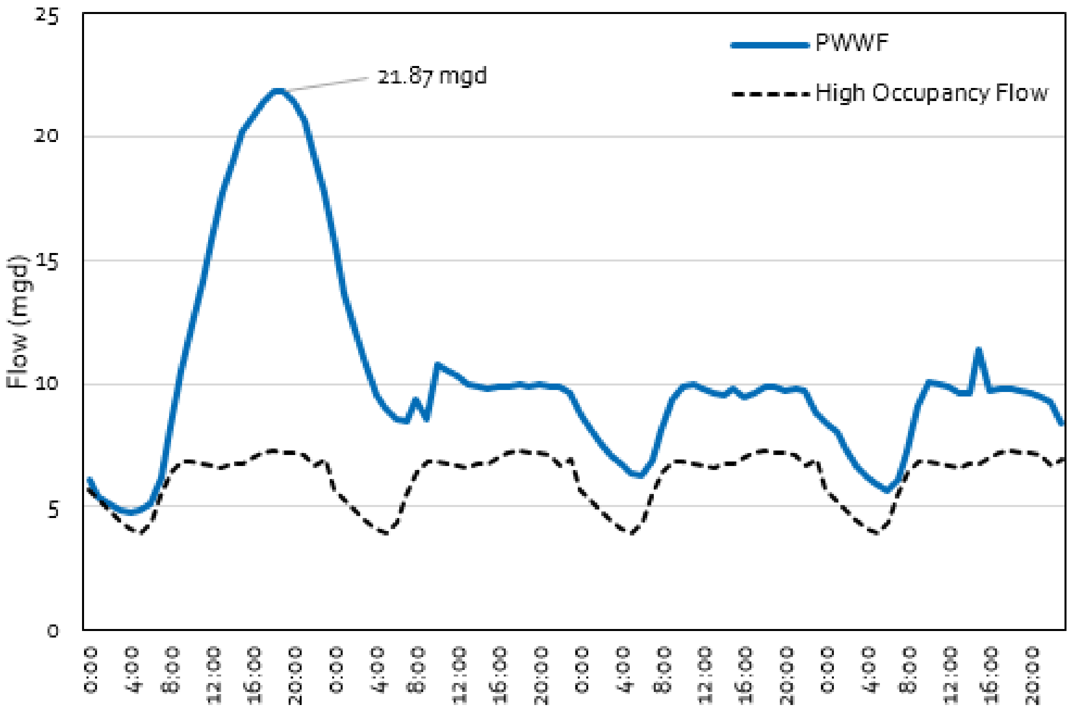

Figure 3.15 Existing Peak Wet Weather Flow

3.4.1.3 2045 Peak Wet Weather Flow

The year 2045 PWWF was estimated by adding the additional HOF projections summarized in Section 3.3 into the model. The future infiltration and inflow was assumed to increase at a rate consistent with the existing PWWF, generally. The future increase in I/I was developed for each agency by applying the existing peak I/I rate to HOF PF to the future HOF increase. The peak I/I rate PFs by agency are provided in Appendix 3B - Wet Weather Flow Projection Detail for reference. A few areas within the existing TRI showed higher than normal peak I/I rates under the existing model runs. These areas include the Northshore Area of TCPUD, ASCWD, and the Martis Valley/Glenshire Areas of TSD. For these areas, it was assumed that future construction would yield a lower rate of I/I than the existing system, and therefore an average peak I/I rate to HOF PF was assumed (see Appendix 3B - Wet Weather Flow Projection Detail for more information).

Once the future peak I/I rate assumptions were built into the model, the model was run to project the future 2045 PWWF, which, as shown in Figure 3.16, is estimated to be approximately 30.0 mgd.

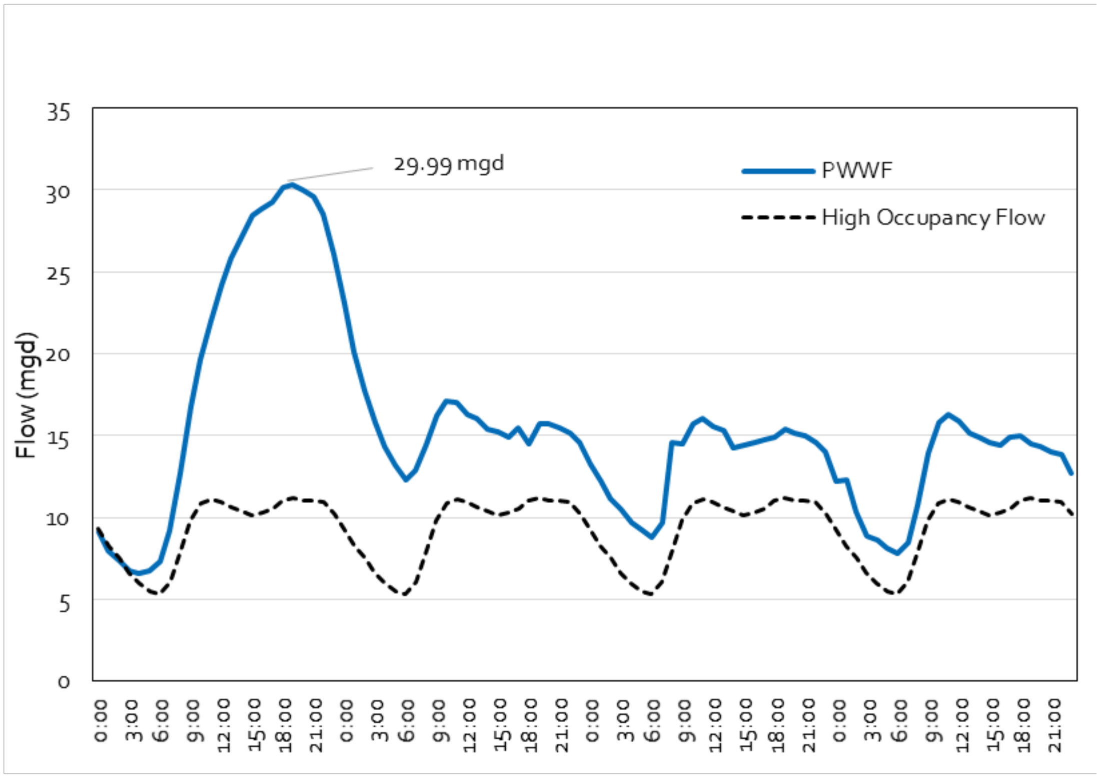

Figure 3.16 2045 Peak Wet Weather Flow

3.5 Flow Projection Summary

Table 3.11 summarizes the existing and future dry and PWWF flows for the TRI. As shown in Table 3.11, the HOF is projected to increase approximately 52 percent to 9.77 mgd by year 2045, and the PWWF is projected to increase by 37 percent to 29.99 by year 2045.

Table 3.11 Existing and Future Flow Summary

Flow Condition	Existing	2045
BWF (mgd)	3.34	5.11
ADWF (mgd)	4.22	6.30
HOF (mgd)	6.44	9.77
PWWF (mgd)	21.87	29.99
PWWF/HOF PF	3.40	3.07

3.6 References

Stantec Consulting, Inc. (2009) North Tahoe Public Utility District Main Sewer Pump Station Master Plan.

NTPUD. (2015) North Tahoe Public Utility District Urban Water Management Plan.

TRPA. (2017) Linking Tahoe – Regional Transportation Plan and Sustainable Communities Strategy, Horizon Year 2017 – 2040.

T-TSA. (2002-2019) Sewer Connection Historical Data.

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County of Placer Community Development/Resource Agency. (2019) Notice of Preparation of an Environmental Impact Report for the Proposed White Wolf Subdivision Project.

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OVPSD. (2000-2019) Sewer Connection Historical Data.

TDPUD. (2016) Truckee Water System 2015 Urban Water Management Plan.

Town of Truckee. (2019) Town of Truckee 2040 General Plan.

Carollo Engineers, Inc. (2019) Truckee Sanitary District Hydraulic Model Assistance Sewer System Hydraulic Model Update.

TSD. (1990-2018) Sewer Connection Historical Data.

Auerbach Engineering Corporation. (2004) Northstar Mountain Properties, LLC Northstar Water Model Project Technical Memorandum.

ECO:LOGIC Engineering. (2005) Northstar Community Services District Sewer Capacity Analysis.

ECO:LOGIC Engineering. (2008) Northstar Community Services District Wastewater Collection System Master Plan.

Farr West Engineering. (2015) Northstar Community Services District Sewer Capacity Analysis – Martis Valley West Technical Memorandum.

Stantec Reno. (2015) Martis Valley West Parcel Project – Water Supply Assessment Technical Memorandum.

NCSD. (2018) Sewer Connection Historical Data.

Appendix 3A

DRY WEATHER FLOW PROJECTION DETAIL

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North Tahoe Public Utility District

Year	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical ADWF (Avg. of 7d avg btw Jun 21 & Sep 21) (mgd)
2018	0.621	1.296	0.859
2019	0.626	1.306	0.865
2020	0.631	1.316	0.872
2021	0.635	1.326	0.879
2022	0.640	1.336	0.886
2023	0.645	1.347	0.892
2024	0.650	1.357	0.899
2025	0.655	1.367	0.906
2026	0.660	1.378	0.913
2027	0.665	1.389	0.920
2028	0.671	1.399	0.927
2029	0.676	1.410	0.934
2030	0.681	1.421	0.942
2031	0.686	1.432	0.949
2032	0.691	1.443	0.956
2033	0.697	1.454	0.963
2034	0.702	1.465	0.971
2035	0.707	1.477	0.978
2036	0.713	1.488	0.986
2037	0.718	1.499	0.993
2038	0.724	1.511	1.001
2039	0.730	1.523	1.009
2040	0.735	1.534	1.017
2041	0.741	1.546	1.024
2042	0.747	1.558	1.032
2043	0.752	1.570	1.040
2044	0.758	1.582	1.048
2045	0.764	1.594	1.056

Master Plan Duration

Parameter	Value	Source
Existing BWF (mgd)	0.621	T-TSA flow meter
Existing HO Flow (mgd)	1.296	T-TSA flow meter
HO:BWF Peaking Factor	2.087	
Assumed Growth Rate (%/year)	0.77%	NTPUD 2015 Urban Water Management Plan
2018 Water Production Requirement (AFY)	1987	Table 9 of KJ Tahoe Basin Demand Analysis
Baseline Water Production Requirement (AFY)	2066	Table 13 of KJ Tahoe Basin Demand Analysis
Future Water Production Requirement (AFY)	2829	Table 32 of KJ Tahoe Basin Demand Analysis
2018 Water Production Requirement (mgd)	1.774	
Baseline Water Production Requirement (mgd)	1.844	
Future Water Production Requirement (mgd)	2.526	
Return to Sewer Ratio	0.337	
Buildout BWF (mgd)	0.850	
Buildout HO Flow (mgd)	1.775	
Buildout ADWF (mgd)	1.176	
ADWF:BWF Peaking Factor	1.383	

Tahoe City Public Utility District

Year	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical ADWF (Avg. of 7d avg btw Jun 21 & Sep 21) (mgd)	
2015	--	--	--	
2016	--	--	--	
2017	--	--	--	
2018	0.517	1.203	0.807	
2019	0.518	1.206	0.809	
2020	0.520	1.209	0.811	
2021	0.521	1.212	0.813	
2022	0.522	1.215	0.816	
2023	0.524	1.219	0.818	
2024	0.525	1.222	0.820	
2025	0.526	1.225	0.822	
2026	0.528	1.228	0.824	
2027	0.529	1.231	0.826	
2028	0.530	1.234	0.828	
2029	0.532	1.237	0.830	
2030	0.533	1.240	0.832	
2031	0.534	1.244	0.834	
2032	0.536	1.247	0.836	
2033	0.537	1.250	0.839	
2034	0.538	1.253	0.841	
2035	0.540	1.256	0.843	
2036	0.541	1.259	0.845	
2037	0.542	1.262	0.847	
2038	0.544	1.265	0.849	
2039	0.545	1.268	0.851	
2040	0.546	1.272	0.853	
2041	0.548	1.275	0.855	
2042	0.549	1.278	0.857	
2043	0.551	1.281	0.860	
2044	0.552	1.284	0.862	
2045	0.553	1.287	0.864	Master Plan Duration

Year	2015 UWMP Growth (Grey)	
2015	5741	
2016	5756	0.26%
2017	5771	0.26%
2018	5786	0.26%
2019	5801	0.26%
2020	5816	0.26%
2021	5831	0.26%
2022	5846	0.26%
2023	5861	0.26%
2024	5876	0.26%
2025	5891	0.26%
2026	5906	0.25%
2027	5921	0.25%
2028	5936	0.25%
2029	5951	0.25%
2030	5966	0.25%
2031	5981	0.25%
2032	5996	0.25%
2033	6011	0.25%
2034	6026	0.25%
2035	6041	0.25%
2036	6056	0.25%
2037	6071	0.25%
2038	6086	0.25%
2039	6101	0.25%
2040	6116	0.25%
2041	6131	0.25%
2042	6146	0.24%
2043	6161	0.24%
2044	6176	0.24%
2045	6191	0.24%

0.25% UWMP average growth rate

Parameter	Value	Source
Existing BWF (mgd)	0.517	T-TSA flow meter
Existing HO Flow (mgd)	1.203	T-TSA flow meter
HO:BWF Peaking Factor	2.327	
Assumed Growth Rate (%/year)	0.25%	TCPUD 2015 Urban Water Management Plan
2018 Water Production Requirement (AFY)	2842	Table 9 of KJ Tahoe Basin Demand Analysis
Baseline Water Production Requirement (AFY)	2956	Table 13 of KJ Tahoe Basin Demand Analysis
Future Water Production Requirement (AFY)	3839	Table 32 of KJ Tahoe Basin Demand Analysis
2018 Water Production Requirement (mgd)	2.537	
Baseline Water Production Requirement (AFY)	2.639	
Future Water Production Requirement (mgd)	3.427	
Return to Sewer Ratio	0.196	
Buildout BWF (mgd)	0.671	
Buildout HO Flow (mgd)	1.562	
Buildout ADWF (mgd)	1.048	
ADWF:BWF Peaking Factor	1.561	

Alpine Springs County Water District

Year	Existing Valley + SFR Development					Alpine Sierra Subdivision			White Wolf Project			Total Flow		
	Estimated SFR	SFR Flow		Other Flow (condo, apt, comm, ski area)		Alpine Sierra SFR	Alpine Sierra Flow		White Wolf SFR	White Wolf Flow				
		Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical BWF (mgd)	High Occupancy DWF (mgd)		Typical BWF (mgd)	High Occupancy DWF (mgd)		Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical ADWF (Avg. of 7d avg btw Jun 21 & Sep 21) (mgd)
2018	496	0.032	0.092	0.013	0.037	0	0.000	0.000	0	0.000	0.000	0.045	0.129	0.054
2019	498	0.032	0.093	0.013	0.037	0	0.000	0.000	0	0.000	0.000	0.045	0.129	0.054
2020	500	0.033	0.093	0.013	0.037	0	0.000	0.000	0	0.000	0.000	0.045	0.130	0.054
2021	502	0.033	0.094	0.013	0.037	0	0.000	0.000	0	0.000	0.000	0.045	0.130	0.054
2022	504	0.033	0.094	0.013	0.037	0	0.000	0.000	0	0.000	0.000	0.046	0.130	0.054
2023	506	0.033	0.094	0.013	0.037	0	0.000	0.000	0	0.000	0.000	0.046	0.131	0.055
2024	508	0.033	0.095	0.013	0.037	0	0.000	0.000	0	0.000	0.000	0.046	0.131	0.055
2025	510	0.033	0.095	0.013	0.037	3	0.000	0.001	0	0.000	0.000	0.046	0.132	0.055
2026	512	0.033	0.095	0.013	0.037	7	0.000	0.001	0	0.000	0.000	0.046	0.133	0.056
2027	514	0.033	0.096	0.013	0.037	10	0.001	0.002	0	0.000	0.000	0.047	0.134	0.056
2028	516	0.034	0.096	0.013	0.037	13	0.001	0.002	0	0.000	0.000	0.047	0.135	0.056
2029	518	0.034	0.097	0.013	0.037	16	0.001	0.003	0	0.000	0.000	0.047	0.136	0.057
2030	520	0.034	0.097	0.013	0.037	20	0.001	0.004	0	0.000	0.000	0.048	0.137	0.057
2031	522	0.034	0.097	0.013	0.037	23	0.001	0.004	0	0.000	0.000	0.048	0.138	0.058
2032	524	0.034	0.098	0.013	0.037	26	0.002	0.005	0	0.000	0.000	0.049	0.139	0.058
2033	526	0.034	0.098	0.013	0.037	29	0.002	0.005	0	0.000	0.000	0.049	0.140	0.058
2034	528	0.034	0.098	0.013	0.037	33	0.002	0.006	0	0.000	0.000	0.049	0.141	0.059
2035	530	0.034	0.099	0.013	0.037	36	0.002	0.007	10	0.001	0.002	0.050	0.144	0.060
2036	532	0.035	0.099	0.013	0.037	39	0.003	0.007	20	0.001	0.004	0.051	0.147	0.061
2037	534	0.035	0.100	0.013	0.037	42	0.003	0.008	30	0.002	0.006	0.052	0.150	0.062
2038	536	0.035	0.100	0.013	0.037	46	0.003	0.008	40	0.003	0.007	0.053	0.152	0.064
2039	538	0.035	0.100	0.013	0.037	49	0.003	0.009	50	0.003	0.009	0.054	0.155	0.065
2040	540	0.035	0.101	0.013	0.037	52	0.003	0.010	58	0.004	0.011	0.055	0.158	0.066
2041	542	0.035	0.101	0.013	0.037	52	0.003	0.010	58	0.004	0.011	0.055	0.158	0.066
2042	544	0.035	0.101	0.013	0.037	52	0.003	0.010	58	0.004	0.011	0.055	0.158	0.066
2043	546	0.036	0.102	0.013	0.037	52	0.003	0.010	58	0.004	0.011	0.055	0.159	0.066
2044	548	0.036	0.102	0.013	0.037	52	0.003	0.010	58	0.004	0.011	0.056	0.159	0.066
2045	550	0.036	0.103	0.013	0.037	52	0.003	0.010	58	0.004	0.011	0.056	0.160	0.067

Alpine Springs County Water District

Parameter	Value	Units	Source
Existing BWF (mgd)	0.045	mgd	T-TSA flow meter
HO:BWF Peaking Factor	2.867		
SFR Q contribution	71.70%		2006 Master Plan
SFR Q	0.0323	mgd	
SFR Q / dwelling unit	65.1	gpd/dwelling unit	
assumed growth rate	2	dwelling units/year	T-TSA historical connections
assumed pop/SFR	2.54	people/dwelling unit	Town of Truckee 2040 General Plan
max SFR (minus Alpine Sierra + White Wolf)	652		2006 Master Plan, Alpine Sierra Final EIR, White Wolf NOP
Alpine Sierra assumed growth rate	3.25	dwelling units/year	Alpine Sierra Final EIR
Alpine Sierra max SFR	52		Alpine Sierra Final EIR
White Wolf assumed growth rate	10	dwelling units/year	2006 Master Plan
White Wolf max SFR	58		White Wolf NOP
Exist HO Flow	0.129	mgd	
SFR HO Flow	0.0925	mgd	
SFR HO Flow / dwelling unit	186.5	gpd/dwelling unit	
Buildout BWF (mgd)	0.062		
Buildout HO Flow (mgd)	0.179		
Buildout ADWF (mgd)	0.074		
ADWF:BWF Peaking Factor	1.19		

Olympic Valley Public Service District

	Existing Valley + SFR Development					Village at Squaw Valley Specific Plan				Resort at Squaw Creek Phase 2			General Plan Development							Total Flow		
		SFR Flow		Other Flow (condo, apt, comm)		VSVSP MFR Flow		VSVSP Comm Flow			RSC Phase 2 Flow		Foreseeable SFR Development Flow			Foreseeable MFR + Comm Flow		Remaining Dev. Flow (MFR + Comm.)				
Year	Estimated SFR	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical BWF (mgd)	High Occupancy DWF (mgd)	RSC Phase 2 condos	Typical BWF (mgd)	High Occupancy DWF (mgd)	SFR Increase	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical BWF (mgd)	HIgh Occupancy DWF (mgd)	Typical BWF (mgd)	High Occupancy DWF (mgd)	Typical ADWF (Avg. of 7d avg btw Jun 21 & Sep 21) (mgd)
2018	1857	0.131	0.334	0.023	0.058	0.000	0.000	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.154	0.392	0.187
2019	1862	0.131	0.334	0.023	0.058	0.000	0.000	0.000	0.000	0	0.000	0.000	5	0.001	0.001	0.000	0.000	0.000	0.000	0.155	0.393	0.188
2020	1867	0.131	0.334	0.023	0.058	0.000	0.000	0.000	0.000	5	0.001	0.002	10	0.001	0.003	0.000	0.000	0.000	0.000	0.156	0.397	0.189
2021	1872	0.131	0.334	0.023	0.058	0.007	0.018	0.003	0.009	22	0.003	0.007	15	0.002	0.004	0.000	0.000	0.000	0.000	0.169	0.430	0.205
2022	1877	0.131	0.334	0.023	0.058	0.014	0.036	0.007	0.018	39	0.005	0.013	20	0.002	0.006	0.000	0.000	0.000	0.000	0.182	0.464	0.221
2023	1882	0.131	0.334	0.023	0.058	0.021	0.054	0.010	0.026	56	0.007	0.018	25	0.003	0.007	0.000	0.000	0.000	0.000	0.195	0.498	0.237
2024	1887	0.131	0.334	0.023	0.058	0.028	0.072	0.014	0.035	73	0.009	0.024	30	0.003	0.009	0.000	0.000	0.000	0.000	0.209	0.531	0.254
2025	1892	0.131	0.334	0.023	0.058	0.035	0.090	0.017	0.044	90	0.011	0.029	35	0.004	0.010	0.000	0.000	0.000	0.000	0.222	0.565	0.270
2026	1897	0.131	0.334	0.023	0.058	0.039	0.100	0.019	0.049	107	0.014	0.035	40	0.005	0.012	0.001	0.003	0.000	0.000	0.232	0.590	0.282
2027	1902	0.131	0.334	0.023	0.058	0.043	0.110	0.021	0.054	124	0.016	0.040	45	0.005	0.013	0.002	0.006	0.000	0.000	0.242	0.615	0.294
2028	1907	0.131	0.334	0.023	0.058	0.047	0.121	0.023	0.059	141	0.018	0.046	50	0.006	0.015	0.003	0.008	0.000	0.000	0.251	0.640	0.306
2029	1912	0.131	0.334	0.023	0.058	0.051	0.131	0.025	0.064	158	0.020	0.051	55	0.006	0.016	0.004	0.011	0.000	0.000	0.261	0.665	0.317
2030	1917	0.131	0.334	0.023	0.058	0.055	0.141	0.027	0.069	175	0.022	0.057	60	0.007	0.017	0.006	0.014	0.000	0.000	0.271	0.690	0.329
2031	1922	0.131	0.334	0.023	0.058	0.059	0.151	0.029	0.074	192	0.024	0.062	65	0.007	0.019	0.007	0.017	0.005	0.012	0.286	0.727	0.347
2032	1927	0.131	0.334	0.023	0.058	0.063	0.162	0.031	0.079	209	0.027	0.068	70	0.008	0.020	0.008	0.020	0.009	0.023	0.300	0.764	0.364
2033	1932	0.131	0.334	0.023	0.058	0.068	0.172	0.033	0.084	226	0.029	0.073	75	0.009	0.022	0.009	0.023	0.014	0.035	0.314	0.800	0.382
2034	1937	0.131	0.334	0.023	0.058	0.072	0.182	0.035	0.089	243	0.031	0.079	80	0.009	0.023	0.010	0.025	0.018	0.047	0.329	0.837	0.400
2035	1942	0.131	0.334	0.023	0.058	0.076	0.192	0.037	0.094	260	0.033	0.084	85	0.010	0.025	0.011	0.028	0.023	0.058	0.343	0.874	0.417
2036	1947	0.131	0.334	0.023	0.058	0.079	0.200	0.038	0.098	263	0.033	0.085	90	0.010	0.026	0.011	0.028	0.028	0.070	0.353	0.899	0.429
2037	1952	0.131	0.334	0.023	0.058	0.082	0.208	0.040	0.101	263	0.033	0.085	95	0.011	0.028	0.011	0.028	0.032	0.082	0.363	0.924	0.441
2038	1957	0.131	0.334	0.023	0.058	0.085	0.215	0.041	0.105	263	0.033	0.085	100	0.011	0.029	0.011	0.028	0.037	0.093	0.373	0.949	0.453
2039	1962	0.131	0.334	0.023	0.058	0.088	0.223	0.043	0.109	263	0.033	0.085	105	0.012	0.031	0.011	0.028	0.041	0.105	0.382	0.973	0.464
2040	1967	0.131	0.334	0.023	0.058	0.091	0.231	0.044	0.113	263	0.033	0.085	110	0.013	0.032	0.011	0.028	0.046	0.117	0.392	0.998	0.476
2041	1972	0.131	0.334	0.023	0.058	0.093	0.236	0.045	0.115	263	0.033	0.085	115	0.013	0.033	0.011	0.028	0.050	0.129	0.400	1.019	0.486
2042	1977	0.131	0.334	0.023	0.058	0.095	0.241	0.046	0.118	263	0.033	0.085	120	0.014	0.035	0.011	0.028	0.055	0.140	0.408	1.039	0.496
2043	1982	0.131	0.334	0.023	0.058	0.097	0.246	0.047	0.120	263	0.033	0.085	125	0.014	0.036	0.011	0.028	0.060	0.152	0.416	1.060	0.506
2044	1987	0.131	0.334	0.023	0.058	0.099	0.251	0.048	0.123	263	0.033	0.085	130	0.015	0.038	0.011	0.028	0.064	0.164	0.425	1.081	0.516
2045	1992	0.131	0.334	0.023	0.058	0.101	0.257	0.049	0.125	263	0.0335	0.085	135	0.0154	0.039	0.011	0.028	0.069	0.175	0.433	1.102	0.526

Olympic Valley Public Service District

Parameter	Value	Units	Source
Exist. Flow (Typical BWF)	0.154	mgd	T-TSA flow meter
HO:BWF Peaking Factor	2.545		
ADWF:BWF Peaking Factor	1.215		
SFR Q contribution	85.14%		2014 VSVSP Sewer Capacity Analysis TM
SFR typical BWF	0.131	mgd	
SFR high occupancy flow / dwelling unit	291	gpd/SFR	2014 VSVSP Sewer Capacity Analysis TM
MFR high occupancy flow / dwelling unit	285	gpd/unit	2014 VSVSP Sewer Capacity Analysis TM
commercial high occupancy flow / square foot	0.38	gpd/sf	2014 VSVSP Sewer Capacity Analysis TM
assumed growth rate	5	dwelling units/year	T-TSA historical connections (2006 - 2019)
assumed pop/SFR	2.54	people/dwelling unit	Town of Truckee 2040 General Plan
max SFR (no condos or commercial)	2001	units	2014 VSVSP Sewer Capacity project is "approved". Assume buildout by 2030
max add'l condos (general dev + VSVSP)	1,561	units	2014 VSVSP Sewer Capacity Analysis TM, 2015 VSVSP WSA
max add'l commercial (general dev + VSVSP)	492,989	sf	2014 VSVSP Sewer Capacity Analysis TM, 2015 VSVSP WSA

Resort at Squaw Creek (RSC)

	Value	Units	Source
RSC Phase 2 max condos	263	units	2014 VSVSP Sewer Capacity Analysis TM
RSC Phase 2 assumed growth rate	17.0	units/year	Placer County: Project is approved; assume buildout by 2035, 263 units/15 years=17.5 units per year
RSC Phase 2 max flow	85,212	gpd	2014 VSVSP Sewer Capacity Analysis TM
RSC Phase 2 MFR high occupancy flow / unit	324	gpd	2014 VSVSP Sewer Capacity Analysis TM

Village at Squaw Valley Specific Plan (VSVSP)

# Condos	Comm SF	MFR max occupancy ADWF (gpd)	Comm max occupancy ADWF (gpd)	Pool filter backwash rate (gpd)	total comm (gpd)	2014 VSVSP Sewer Capacity Analysis TM
900	297,733	256,500	113,139	12,000	125,139	

Project timing

Year	% Buildout	avg % / year	
2020	0%		2015 VSVSP Water Supply Assessment
2025	35%	7%	timing shifted back 5 years per convo with Dave Hunt, SVSPD (10/2019)
2030	55%	4%	
2035	75%	4%	
2040	90%	3%	
2045	100%	2%	

Foreseeable projects (assume buildout within 10 years, 2025-2035)

Name	# Condos	Comm SF	MFR max occupancy flow (gpd)	Comm max occupancy (gpd)	Q/year (gpd)	2014 VSVSP Sewer Capacity Analysis TM		
Squaw Valley Park / Olympic Valley Museum	0	14,500	0	5,510	551	flow/MFR	318.8	gpd
PlumpJacks	62	7,799	19,764	2,964	2,273	flow/sf	0.38	gpd
TOTAL	**62**	**22,299**		**28,238**	**2,824**			

Remaining projects (assume buildout within 15 years, 2030-2045)

Name	# Condos	Comm SF	MFR max occupancy flow (gpd)	Comm max occupancy (gpd)	Q/year (gpd)	2014 VSVSP Sewer Capacity Analysis TM		
Squaw Valley Academy	2	11,000	648	4,180	321.9			
7-11, Tahoe Dave's	74	15,490	23,814	5,886	1980.0			
Empty lot	0	12,001	0	4,560	304.0	flow/MFR	301.2	gpd
SVPSD old facility	75	25,000	12,150	9,500	1443.3	flow/sf	0.38	gpd
Mrs. Poulson compound	83	10,000	26,811	3,800	2040.7			
east of Meadows End Court	26	5,000	8,335	1,900	682.3			
Post Office	43	1,264	13,770	480	950.0			
Homestead Project, Graham's Restaurant	-7	-2,500	-1,134	-950	-138.9			
Homestead Project, 7 plex	0	-940	-324	-357	-45.4			
Homestead Project, Old Bear Pen	6	-5,220	1,944	-1,984	-2.7			
Homestead Project, empty lot	28	7,280	9,072	2,766	789.2			
Homestead Project, empty lot	18	7,020	8,748	2,668	761.1			
Empty lot, PSF water tank	15	3,738	4,658	1,420	405.2			
Empty lot, PSF water tank	3	824	1,027	313	89.3			
Sena	0	27,000	0	10,260	684.0			
Sena / SV Prep	0	56,000	0	21,280	1418.7			
TOTAL	**364**	**172,957**	**109,519**	**65,722**	**11682.7**			
			TOTAL Flows	**175,241**				

Truckee Sanitary District + Northstar Community Services District

Year	Existing Flow: TSD Typical BWF (mgd)	Existing Flow: TSD High Occupancy DWF (mgd)	Existing Flow: Northstar CSD Typical BWF (mgd)	Existing Flow: Northstar CSD High Occupancy DWF (mgd)	Existing Flow: Total Typical BWF (mgd)	Existing Flow: Total High Occupancy DWF (mgd)	TSD Flow Increase: Number of New EDUs	TSD Flow Increase: Typical BWF (mgd)	TSD Flow Increase: High Occupancy DWF (mgd)	Northstar Flow Increase: SFR Increase in SFR	SFR Typical BWF (mgd)	SFR High Occupancy DWF (mgd)	Condos Increase in Condos	Condos Typical BWF (mgd)	Condos High Occupancy DWF (mgd)
2018	1.735	2.979	0.275	0.471	2.010	3.450	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000
2019	1.735	2.979	0.275	0.471	2.010	3.450	300	0.040	0.069	4	0.001	0.001	2	0.000	0.000
2020	1.735	2.979	0.275	0.471	2.010	3.450	600	0.080	0.138	8	0.001	0.002	6	0.001	0.001
2021	1.735	2.979	0.275	0.471	2.010	3.450	900	0.121	0.207	12	0.002	0.003	10	0.001	0.002
2022	1.735	2.979	0.275	0.471	2.010	3.450	1,200	0.161	0.276	16	0.002	0.004	14	0.002	0.003
2023	1.735	2.979	0.275	0.471	2.010	3.450	1,500	0.201	0.345	20	0.003	0.005	18	0.002	0.004
2024	1.735	2.979	0.275	0.471	2.010	3.450	1,800	0.241	0.414	24	0.003	0.006	22	0.003	0.004
2025	1.735	2.979	0.275	0.471	2.010	3.450	2,100	0.281	0.483	28	0.004	0.006	26	0.003	0.005
2026	1.735	2.979	0.275	0.471	2.010	3.450	2,400	0.322	0.552	32	0.004	0.007	30	0.003	0.006
2027	1.735	2.979	0.275	0.471	2.010	3.450	2,700	0.362	0.621	36	0.005	0.008	34	0.004	0.007
2028	1.735	2.979	0.275	0.471	2.010	3.450	3,000	0.402	0.690	40	0.005	0.009	38	0.004	0.008
2029	1.735	2.979	0.275	0.471	2.010	3.450	3,300	0.442	0.759	44	0.006	0.010	42	0.005	0.008
2030	1.735	2.979	0.275	0.471	2.010	3.450	3,600	0.482	0.828	48	0.006	0.011	46	0.005	0.009
2031	1.735	2.979	0.275	0.471	2.010	3.450	3,900	0.523	0.897	52	0.007	0.012	50	0.006	0.010
2032	1.735	2.979	0.275	0.471	2.010	3.450	4,200	0.563	0.966	56	0.008	0.013	54	0.006	0.011
2033	1.735	2.979	0.275	0.471	2.010	3.450	4,500	0.603	1.035	60	0.008	0.014	58	0.007	0.012
2034	1.735	2.979	0.275	0.471	2.010	3.450	4,800	0.643	1.104	64	0.009	0.015	62	0.007	0.012
2035	1.735	2.979	0.275	0.471	2.010	3.450	5,100	0.683	1.173	68	0.009	0.016	66	0.008	0.013
2036	1.735	2.979	0.275	0.471	2.010	3.450	5,400	0.724	1.242	72	0.010	0.017	70	0.008	0.014
2037	1.735	2.979	0.275	0.471	2.010	3.450	5,700	0.764	1.311	76	0.010	0.017	74	0.009	0.015
2038	1.735	2.979	0.275	0.471	2.010	3.450	6,000	0.804	1.380	80	0.011	0.018	78	0.009	0.016
2039	1.735	2.979	0.275	0.471	2.010	3.450	6,300	0.844	1.449	84	0.011	0.019	82	0.010	0.016
2040	1.735	2.979	0.275	0.471	2.010	3.450	6,600	0.884	1.518	88	0.012	0.020	86	0.010	0.017
2041	1.735	2.979	0.275	0.471	2.010	3.450	6,900	0.925	1.587	92	0.012	0.021	90	0.010	0.018
2042	1.735	2.979	0.275	0.471	2.010	3.450	7,200	0.965	1.656	96	0.013	0.022	94	0.011	0.019
2043	1.735	2.979	0.275	0.471	2.010	3.450	7,500	1.005	1.725	100	0.013	0.023	98	0.011	0.020
2044	1.735	2.979	0.275	0.471	2.010	3.450	7,800	1.045	1.794	104	0.014	0.024	102	0.012	0.020
2045	1.735	2.979	0.275	0.471	2.010	3.450	8,100	1.085	1.863	108	0.014	0.025	106	0.012	0.021

Year	Northstar Flow Increase: Martis Valley West SFR Increase in SFR	MVW SFR Typical BWF (mgd)	MVW SFR High Occupancy DWF (mgd)	Martis Valley West Condos Increase in Condos	MVW Condos Typical BWF (mgd)	MVW Condos High Occupancy DWF (mgd)	Martis Valley West Comm. Increase in Comm SF	MVW Comm. Typical BWF (mgd)	MVW Comm. High Occupancy DWF (mgd)	MVW Total Typical BWF (mgd)	MVW Total High Occupancy DWF (mgd)	Total Flow: TSD Only Typical BWF (mgd)	TSD Only High Occupancy DWF (mgd)	TSD Only Typical ADWF (Avg. of 7d avg btw Jun 21 & Sep 21) (mgd)	NCSD Only Typical BWF (mgd)	NCSD Only High Occupancy DWF (mgd)	NCSD Only Typical ADWF (Avg. of 7d avg btw Jun 21 & Sep 21) (mgd)	Total (TSD + NCSD) Typical BWF (mgd)	Total (TSD + NCSD) High Occupancy DWF (mgd)
2018	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	1.735	2.979	1.993	0.275	0.471	0.316	2.010	3.450
2019	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	1.776	3.048	2.040	0.275	0.473	0.316	2.051	3.520
2020	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	1.816	3.117	2.086	0.276	0.475	0.318	2.092	3.591
2021	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	1.856	3.186	2.132	0.277	0.476	0.319	2.133	3.662
2022	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	1.896	3.255	2.178	0.278	0.478	0.320	2.175	3.732
2023	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	1.936	3.324	2.224	0.279	0.480	0.321	2.216	3.803
2024	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	1.977	3.393	2.270	0.280	0.481	0.322	2.257	3.874
2025	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000	0.000	2.017	3.462	2.317	0.281	0.483	0.323	2.298	3.945
2026	19	0.004	0.007	19	0.004	0.007	2,725	0.001	0.001	0.009	0.015	2.057	3.531	2.363	0.291	0.500	0.334	2.348	4.030
2027	38	0.008	0.015	39	0.008	0.013	5,450	0.001	0.002	0.017	0.030	2.097	3.600	2.409	0.301	0.516	0.345	2.398	4.116
2028	56	0.013	0.022	58	0.011	0.020	8,175	0.002	0.003	0.026	0.044	2.137	3.669	2.455	0.310	0.533	0.357	2.448	4.201
2029	75	0.017	0.029	77	0.015	0.026	10,900	0.002	0.004	0.035	0.059	2.178	3.738	2.501	0.320	0.549	0.368	2.498	4.287
2030	94	0.021	0.036	96	0.019	0.033	13,625	0.003	0.005	0.043	0.074	2.218	3.807	2.548	0.330	0.566	0.379	2.547	4.372
2031	113	0.025	0.044	116	0.023	0.039	16,350	0.004	0.006	0.052	0.089	2.258	3.876	2.594	0.339	0.582	0.390	2.597	4.458
2032	131	0.030	0.051	135	0.027	0.046	19,075	0.004	0.007	0.060	0.104	2.298	3.945	2.640	0.349	0.599	0.401	2.647	4.543
2033	150	0.034	0.058	154	0.030	0.052	21,800	0.005	0.008	0.069	0.119	2.338	4.014	2.686	0.359	0.615	0.412	2.697	4.629
2034	169	0.038	0.066	173	0.034	0.059	24,525	0.005	0.009	0.078	0.133	2.379	4.083	2.732	0.368	0.632	0.423	2.747	4.715
2035	188	0.042	0.073	193	0.038	0.065	27,250	0.006	0.010	0.086	0.148	2.419	4.152	2.778	0.378	0.649	0.434	2.797	4.800
2036	206	0.047	0.080	212	0.042	0.072	29,975	0.006	0.011	0.095	0.163	2.459	4.221	2.825	0.388	0.665	0.445	2.846	4.886
2037	225	0.051	0.088	231	0.046	0.078	32,700	0.007	0.012	0.104	0.178	2.499	4.290	2.871	0.397	0.682	0.456	2.896	4.971
2038	244	0.055	0.095	250	0.049	0.085	35,425	0.008	0.013	0.112	0.193	2.539	4.359	2.917	0.407	0.698	0.467	2.946	5.057
2039	263	0.059	0.102	270	0.053	0.091	38,150	0.008	0.014	0.121	0.208	2.580	4.428	2.963	0.416	0.715	0.478	2.996	5.142
2040	281	0.064	0.109	289	0.057	0.098	40,875	0.009	0.015	0.130	0.222	2.620	4.497	3.009	0.426	0.731	0.489	3.046	5.228
2041	300	0.068	0.117	308	0.061	0.104	43,600	0.009	0.016	0.138	0.237	2.660	4.566	3.055	0.436	0.748	0.501	3.096	5.313
2042	319	0.072	0.124	327	0.065	0.111	46,325	0.010	0.017	0.147	0.252	2.700	4.635	3.102	0.445	0.764	0.512	3.145	5.399
2043	338	0.076	0.131	347	0.068	0.117	49,050	0.011	0.018	0.155	0.267	2.740	4.704	3.148	0.455	0.781	0.523	3.195	5.484
2044	356	0.081	0.139	366	0.072	0.124	51,775	0.011	0.019	0.164	0.282	2.781	4.773	3.194	0.465	0.798	0.534	3.245	5.570
2045	375	0.085	0.146	385	0.076	0.131	54,500	0.012	0.020	0.173	0.297	2.821	4.842	3.240	0.474	0.814	0.545	3.295	5.656

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Truckee Sanitary District + Northstar Community Services District

Parameter	Value	Units	Source
Existing BWF (TSD + NCSD)	2.010	mgd	T-TSA flow meter
Existing High Occupancy flows (TSD + NCSD)	3.450	mgd	2019 TSD Sewer System Hydraulic Model Update TM
HO:BWF Peaking Factor	1.716		
ADWF:BWF Peaking Factor	1.149		
TSD EDUs/yr	300		TSD data (1990-2018)
TSD H.O. Flow/EDU	230	mgd/EDU	2019 TSD Sewer System Hydraulic Model Update TM
Buildout High Occupancy Flow (TSD Only)	5.527	mgd	
Existing High Occupancy Flow (TSD only)	2.979	mgd	
Buildout High Occupancy Flow (TSD + NCSD)	6.550	mgd	2019 TSD Sewer System Hydraulic Model Update TM
NCSD SFR/Year	4		NCSD email
NCSD Max SFR (minus Martis Valley West)	1,373		NCSD Residential Unit Calc
NCSD Current SFR	813		
NCSD Max Condo (minus Martis Valley West)	2,373		NCSD Residential Unit Calc
NCSD Current Condos	1,304		
NCSD Condos per year	2		
NCSD Flow per Condo	200	gpd/unit	
NCSD Assumed Commercial Growth Rate	2%		T-TSA Historical Connections, 2001-2019
NCSD Current Commercial	355,300	sf	NCSD email
NCSD Max Commercial	400,803	sf	2008 NCSD Wastewater Collection System Master Plan
NCSD H.O. Flow/SFR (includes infiltration)	389	gpd/dwelling unit	2015 NCSD Sewer Capacity Analysis - Martis Valley West
NCSD H.O. Flow per condo/townhouse (includes	339	gpd/dwelling unit	2015 NCSD Sewer Capacity Analysis - Martis Valley West
NCSD H.O. Flow per commercial (includes infiltra	0.37	gpd/sf	2015 NCSD Sewer Capacity Analysis - Martis Valley West
Existing High Occupancy Flow (NCSD only)	0.471	mgd	2019 TSD Sewer System Hydraulic Model Update TM
Buildout High Occupancy Flow (NCSD only)	1.023	mgd	2019 TSD Sewer System Hydraulic Model Update TM (Assume this includes Martis Valley West)
High Occupancy flow from buildout only (NCSD)	0.552	mgd	

Martis Valley West			
Martis Valley West max SFR	375		2015 NCSD Sewer Capacity Analysis - Martis Valley West
Martis Valley West max condo+cabins	385		2015 NCSD Sewer Capacity Analysis - Martis Valley West
Martis Valley West max commercial	54,500	sf	2015 NCSD Sewer Capacity Analysis - Martis Valley West
Martis Valley West assumed SFR growth rate	18.75	dwelling units/year	2015 NCSD Sewer Capacity Analysis - MVW (20 year development period)
Martis Valley West assumed condo growth rate	19.25	dwelling units/year	2015 NCSD Sewer Capacity Analysis - MVW (20 year development period)
Martis Valley West assumed comm growth rate	2,725	sf/year	2015 NCSD Sewer Capacity Analysis - MVW (20 year development period)

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Appendix 3B

WET WEATHER FLOW PROJECTION DETAIL

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TRI Connection	High Occupancy Flow (mgd)	Existing Peak I/I Rate[1] (mgd)	Existing Peak I/I Rate/High Occupancy Flow Peaking Factor[2]	Assumed Future Peak I/I Rate/High Occupancy Flow Peaking Factor[2]
TCPUD West Shore	0.926	1.695	1.83	1.83
TCPUD Northshore	0.277	4.342	***15.68***	***2.31***
NTPUD	1.296	2.208	1.70	1.70
Squaw	0.392	0.762	1.94	1.94
Alpine	0.129	0.352	***2.73***	***2.31***
Donner Lake	0.724	1.114	1.54	1.54
Tahoe Donner	1.507	1.912	1.27	1.27
Winter Creek	0.159	0.305	1.92	1.92
Martis Valley	0.614	2.275	***3.71***	***2.31***
Glenshire	0.416	1.031	***2.48***	***2.31***
Total	6.44	14.877	2.31	1.50

Notes:

(1) Peak I/I Rate does not include the influence of dry weather flows.

(2) Peaking factors highlishted with bold italics showed existing peak I/I rates above typical values. For future peak I/I rates, an assumed peaking factor of 2.31 was used (which is the esxiting system-wide peaking factor).

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Tahoe-Truckee Sanitation Agency
Master Sewer Plan

VOLUME 2:
COLLECTION SYSTEM MASTER PLAN
CHAPTER 4:
HYDRAULIC MODEL DEVELOPMENT

FINAL | February 2022

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CIVIL
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Chapter 4

HYDRAULIC MODEL DEVELOPMENT

4.1 Introduction

The Tahoe-Truckee Sanitation Agency (T-TSA) provides wastewater treatment and collection for the North Lake Tahoe and Truckee region. Wastewater is conveyed to the Water Reclamation Plant (WRP) via the Truckee River Interceptor (TRI). The TRI flows south to north and begins in Tahoe City and follows the Truckee River and State Highway 89 to the Town of Truckee. T-TSA contracted Carollo Engineers, Inc. (Carollo) to assist in developing its Master Sewer Plan (Master Plan). As a part of this Master Plan, a hydraulic computer model of T-TSA's conveyance system was developed. This chapter provides an overview of the hydraulic model construction and calibration for the TRI.

4.2 Hydraulic Model Development

A sewer collection system hydraulic model is a simplified representation of the real sewer system. A hydraulic model can assess the conveyance capacity for a collection system and can also be used to perform "what if" scenarios to assess the impacts of future developments and land use changes. This section summarizes the hydraulic model construction.

4.2.1 Previous Hydraulic Modeling Software

T-TSA's previous hydraulic model was constructed by a previous consultant in 2014. The hydraulic model used MIKE URBAN by Danish Hydraulic Institute (DHI) hydraulic modeling software. The MIKE URBAN software application supports two computational engines for urban hydrology and open channel/closed pipe hydraulics: the Environmental Protection Agency's (EPA's) open source Storm Water Management Model (SWMM) 5 engine, and DHI's proprietary MOUSE computational engine.

4.2.2 Selected Hydraulic Modeling Software

Carollo compared and evaluated various hydraulic modeling software packages that could be used to model T-TSA's TRI in Technical Memorandum 1 - Hydraulic Modeling Software Evaluation. It was agreed that InfoSWMM by Innovyze would be used to assemble T-TSA's hydraulic model. InfoSWMM is a fully dynamic, geospatial wastewater modeling and management software application, which is built to run within ESRI's ArcGIS software platform. The hydraulic modeling engine for the InfoSWMM software package uses the EPA's SWMM, which is widely used throughout the world for planning, analysis, and design related to stormwater runoff, combined sewers, sanitary sewers, and other drainage systems. InfoSWMM routes flows through the model using the Dynamic Wave method, which solves the complete Saint-Venant one-dimensional equations of fluid flow.

4.2.3 Elements of the Hydraulic Model

The following provides an overview of the elements of a hydraulic wastewater model and the required input parameters associated with each:

- Manholes: Sewer manholes, cleanouts, as well as other locations where pipe sizes change, where pipelines intersect, or where force mains connect to gravity mains, are represented by manholes in the hydraulic model. Required inputs for manholes include diameter, sanitary loads, and ground, rim, and invert elevations. Manholes can also be used to represent locations where flows are split or diverted between two or more downstream links.
- Conduits: Gravity sewers are represented as conduits in the hydraulic model. Input parameters for conduits include length, diameter, material, friction factor (i.e., Manning's *n*), and invert elevations.
- Pressure Pipes: Force mains are represented as pressure pipes in the hydraulic model. Required input parameters are length, diameter, invert elevations, and friction factor (i.e., Hazen-Williams *C*).
- Pressure Junctions: Pressure junctions are used to connect multiple force main segments. They are needed when an individual pipe changes in diameter or material and can be used to represent a pressure gauge. Required input includes ground and node elevations. Node elevations correspond to inverts of the contiguous pressure pipes.
- Wet Wells: Required input parameters for wet wells include cross section type (circular or variable area), wet well diameter or cross sectional area, and wet well base (bottom), ground (top), maximum (high water level), and minimum (low water level) elevations.
- Pumps: Pumps are included in the hydraulic model as nodes. Input parameters for pumps include type (single point, multiple point, variable speed, etc.), pump capacity/head information, operational controls (on/off set points), ground elevation, and pump invert elevation.
- Outfalls: Outfalls represent areas where flow leaves the system. For sewer system modeling, an outfall typically represents the connection to the influent pump station at a wastewater treatment plant. Required input parameters include boundary conditions (free outfall, normal, user-defined tailwater, etc.), ground elevation, and invert elevation.
- Patterns: Diurnal patterns are used to simulate the variation in flow throughout the day. Patterns can be established for any time period, including multi-day patterns (48-hour, 72-hour, etc.).
- Flows: The following are the two types of wastewater flow sources that can be injected into individual model elements:
  - Loads. Loads simulate base sanitary wastewater flows and represent the average flow. The base flows are multiplied by a pattern that varies the flow temporally. The base flow diurnal patterns are adjusted during the dry weather calibration process. Sanitary loads can be applied to manholes, wet wells, and pressure junctions.
  - Stormwater Flows. Rain-derived infiltration and inflow (RDII) are applied in the model by assigning a unit hydrograph and a corresponding catchment to a given loading manhole. The unit hydrographs consists of several parameters that are used to adjust the volume of RDII that enters the system at a given location. These parameters are adjusted during the wet weather calibration process.

4.2.4 Hydraulic Model Construction

The TRI hydraulic model combines information on the physical and operational characteristics of the wastewater collection system, and performs calculations to solve a series of mathematical equations to simulate flows in pipes. The TRI hydraulic model is shown in Figure 4.1. The model construction process consisted of five steps, as described below:

- *Step 1:* T-TSA's previous hydraulic model (constructed with MIKE URBAN hydraulic modeling software) and geographical information system (GIS) shapefiles for the sewer collection system were obtained. Elevations are based on the North American Vertical Datum of 1988 (NAVD88) datum.
- *Step 2:* The previous hydraulic model data were exported to GIS shapefiles, and compared against T-TSA's GIS database. Based on this comparison, it was determined that the pipe diameter and invert data in the previous hydraulic model was consistent with the most recently available manhole invert and rim survey information performed by T-TSA. The MIKE URBAN model exports were then formatted to allow easy import into the InfoSWMM modeling platform.
- *Step 3:* The MIKE URBAN model exports were imported into the InfoSWMM hydraulic modeling platform. Physical and operational data for special structures in the TRI do not seamlessly transfer from MIKE URBAN to InfoSWMM. Physical and operational data for these structures, such as diversion structures, were input manually into the model based on available information. Figure 4.2 shows the locations of the special structures that were input in the TRI hydraulic model, based on as-built drawings of the TRI. The special structures shown on Figure 4.2 were modeled as a combination of storage nodes (or wet wells) with the physical dimensions of the structure, weirs, and orifices (which simulate the operation of slide gates under various flow conditions). The crossover structure and Pond B diversion were modeled as distinct structures. The flumes installed in the TRI were assumed to have a negligible impact on system hydraulics and were not explicitly included in the model. In addition, pipelines and junctions with missing inverts or invert discrepancies were reviewed and manually input or modified based on the T-TSA's as-built records and survey data. Recent T-TSA projects were reviewed to insure the model reflected the latest information. The boundary conditions at the WRP affect hydraulic conditions in the TRI. The hydraulic model of the WRP, which was updated to include T-TSA's 2020 Headworks Improvement Project, was used to update head/flow boundary conditions in the TRI model. The WRP head stage versus influent flow rate curve, shown in Figure 4.3, was included in the hydraulic model to mimic the operation of the WRP. Once all the relevant data were input into the hydraulic model, the model was reviewed to verify that the model data were input correctly and that the flow direction and size of the modeled pipelines were logical.
- *Step 4:* Dry weather wastewater flows were then allocated to the appropriate model junctions.
- *Step 5:* The hydraulic model contains certain run parameters that need to be set by the user at the beginning of the project. These include run dates, time steps, reporting parameters, output units, and flow routing method. Once the run parameters were established, the model was debugged to ensure that it ran without errors or warnings.

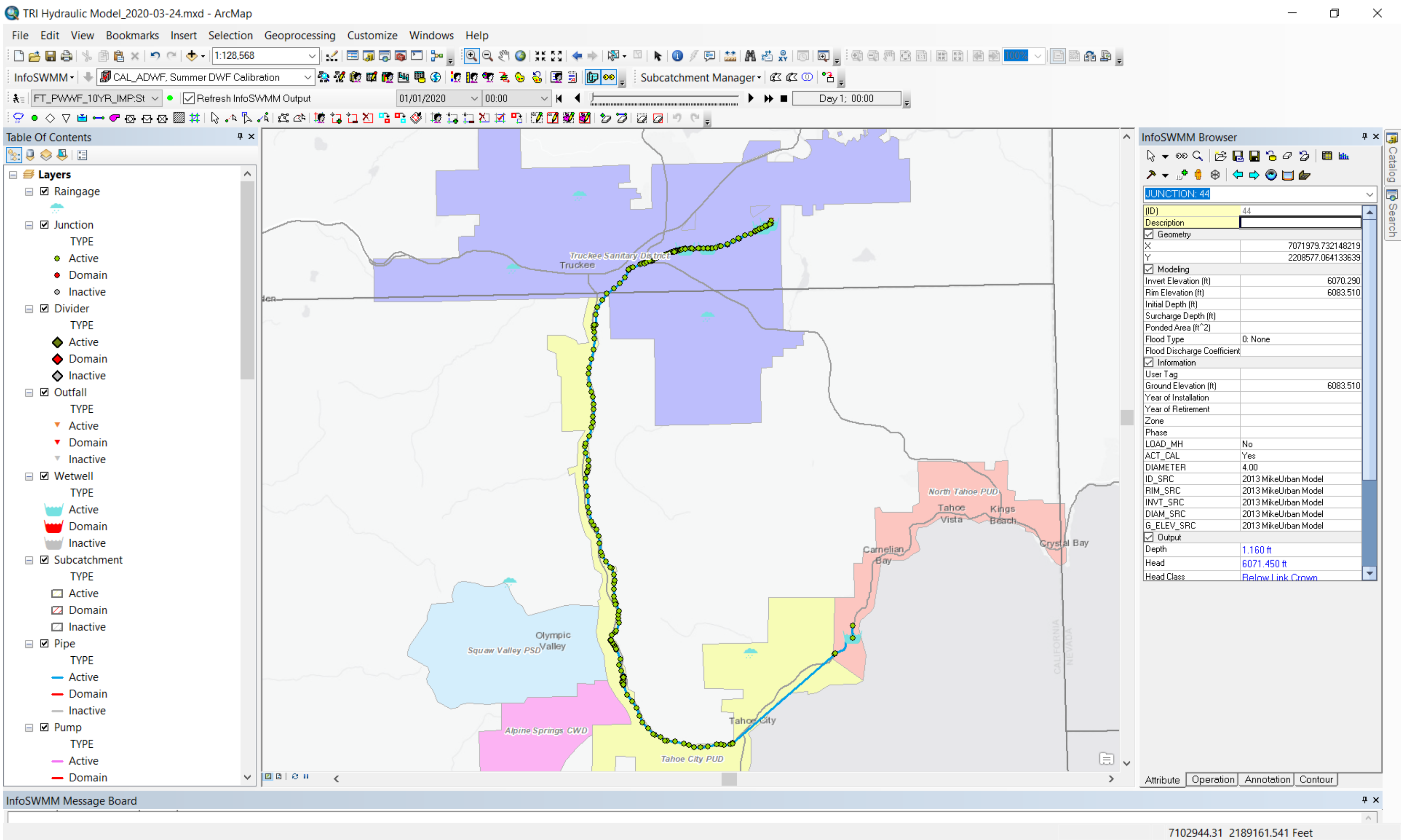


Figure 4.1 TRI Hydraulic Model

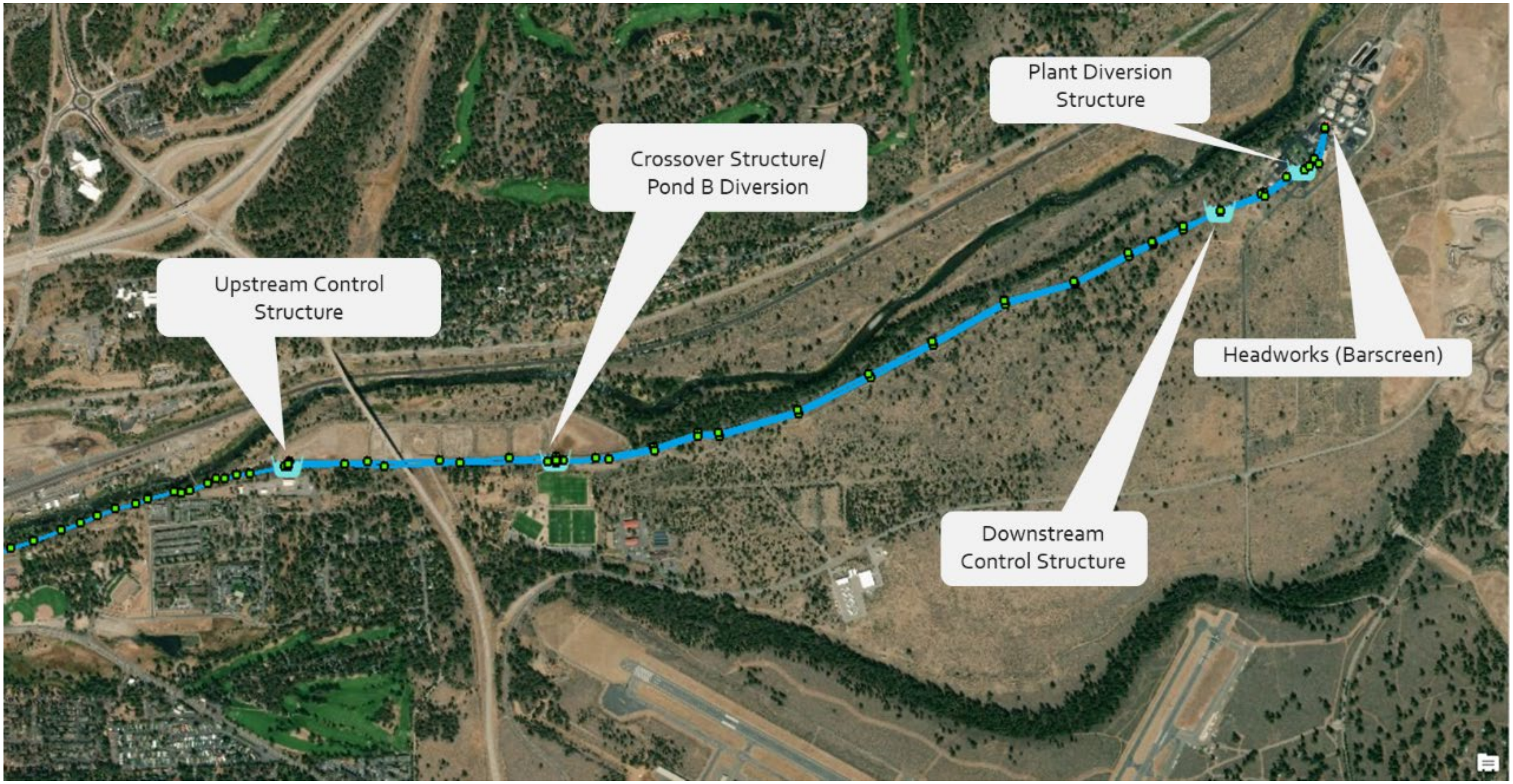


Figure 4.2 Special Structures in TRI Hydraulic Model

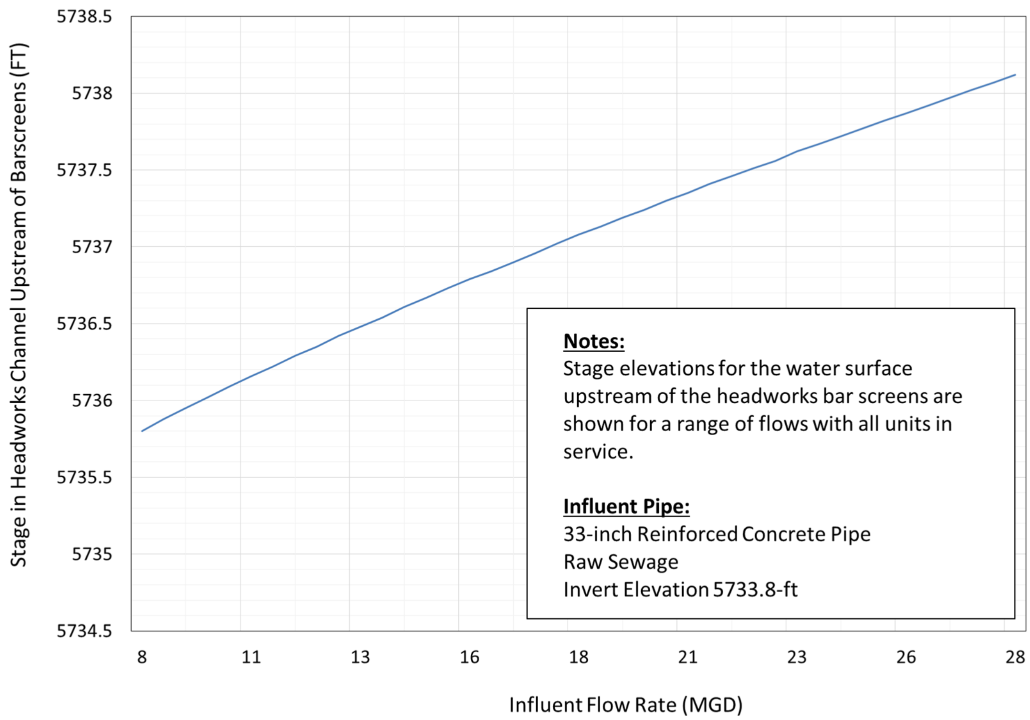


Figure 4.3 Additional Modeled Infrastructure

4.2.5 Wastewater Load Allocation

Determining the quantity of average dry weather flows (ADWFs) generated by a municipality and how they are distributed throughout the collection system is a critical component of the hydraulic modeling process. For the TRI hydraulic model, the load allocation process consisted of adding point loads representing the flow inputs of each contributing agency at the appropriate model manhole location. Modeled ADWFs were allocated based on the information presented in Volume 2, Chapter 3 of this report.

4.3 Hydraulic Model Calibration

Hydraulic model calibration is a crucial component of the hydraulic modeling effort. Calibrating the model to match data collected during the flow monitoring program ensures the most accurate results possible. The calibration process consists of calibrating to both dry and wet weather conditions. This section summarizes the overall methodology employed to calibrate the T-TSA sanitary sewer collection system hydraulic model and the calibration results, including a detailed description of each of the major components of the model calibration process.

4.3.1 Calibration Standards

The hydraulic model was calibrated in accordance with international modeling standards. The Wastewater Planning Users Group (WaPUG), a section of the Chartered Institution of Water and Environmental Management, has established generally agreed upon principles for model verification. The dry weather and wet weather calibration focused on meeting the recommendations on model verification contained in the "Code of Practice for the Hydraulic Modeling of Sewer Systems," published by the WaPUG (WaPUG 2002), as summarized below:

- Dry Weather Calibration Standards: Dry weather calibration should be carried out for two dry weather days and the modeled flows and depths should be compared to the field measured flows and depths. Both the modeled and field measured flow hydrographs should closely follow each other in both shape and magnitude. In addition to the shape, the flow hydrographs should also meet the following criteria as a general guide:
  - The timing of flow peaks and troughs should be within 1 hour.
  - The peak flow rate should be within the range of ±10 percent.
  - The volume of flow (or the average rate of flow) should be within the range of ±10 percent. If applicable, care should be taken to exclude periods of missing or inaccurate data.
- Wet Weather Calibration Standards: The model simulated flows should be compared to the field measured flows. The flow hydrographs for both events should closely follow each other in both shape and magnitude, until the flow has substantially returned to dry weather flow rates. In addition to the shape, the flow hydrographs should also meet the following criteria as a general guide:
  - The timing of the peaks and troughs should be similar with regard to the duration of the events.
  - The peak flow rates at significant peaks should be in the range of +25 percent to -15 percent and should be generally similar throughout.
  - The volume of flow (or the average flow rate) should be within the range of +20 percent to -10 percent.

4.3.2 Dry Weather Flow Calibration

A dry weather flow (DWF) calibration provides an accurate representation of typical base flow conditions. The DWF calibration process consists of several elements, as outlined below:

- Allocate Dry Weather Flow. The first step in the calibration process was to allocate the dry weather flow associated with each contributing agency, as described in Section 4.2.5. This allocation was performed based on the contributing agency flows defined in Volume 2, Chapter 3. Volume 2, Chapter 3 - Historic and Future Flows also includes a schematic of the permanent flowmeter locations.
- Create Diurnal Patterns to Match the Temporal Distribution of Flow. A diurnal curve is a pattern of hourly multipliers that are applied to the base flow to simulate the variation in flow that occurs throughout the day. Two diurnal curves were developed for each contributing agency, one representing weekday flow, and one representing weekend flow. The diurnal patterns were initially developed based on the flow monitoring data, and adjusted as part of the calibration process until the model simulated flows matched the field measured flows as closely as possible. Figure 4.4 shows the calibrated weekday and weekend diurnal pattern for the Alpine Springs County Water District (ASCWD) flowmeter. Additional diurnal patterns were developed for the remaining contributing agencies. These diurnal patterns are found on the DWF calibration sheets that are included in Appendix 4A.

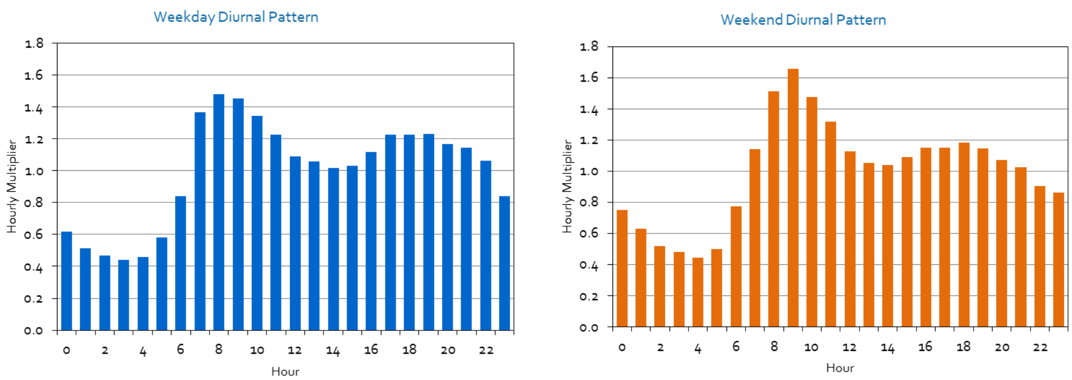
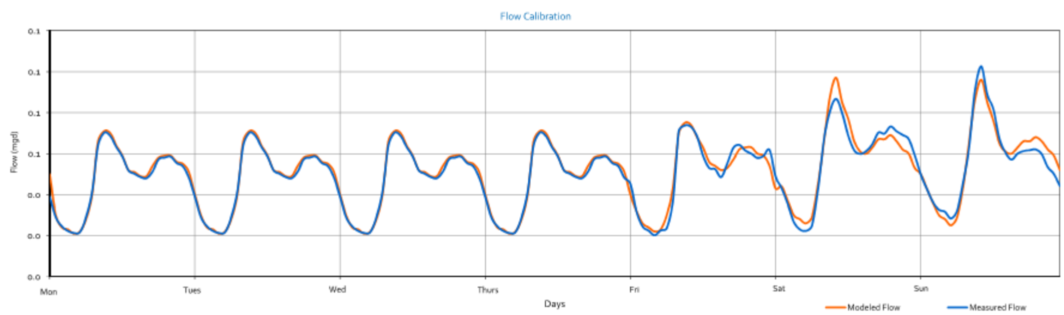


Figure 4.4 Example Weekday and Weekend ADWF Diurnal Patterns (ASCWD)

Figure 4.5 is an example DWF calibration sheet for the ASCWD flowmeter. The calibration sheets provided in Appendix 4A provide plots and tables that compare the model simulated results to the field measured results. As shown in Appendix 4A, the model was successfully calibrated to each flow monitoring site for DWF conditions.



Model Calibration Summary

Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	0.05	0.07	0.05	0.07	2.4%	1.2%
Tues.	0.05	0.07	0.05	0.07	1.5%	1.2%
Wed.	0.05	0.07	0.05	0.07	1.5%	1.2%
Thur.	0.05	0.07	0.05	0.07	1.5%	1.2%
Fri.	0.05	0.07	0.05	0.08	1.3%	1.7%
Sat.	0.06	0.09	0.06	0.10	0.9%	11.9%
Sun.	0.06	0.10	0.06	0.10	1.3%	-6.4%
Summary						
Weekday	0.05	--	0.05	--	1.6%	--
Weekend	0.06	--	0.06	--	1.1%	--
ADWF[4]	0.05	--	0.05	--	1.5%	--

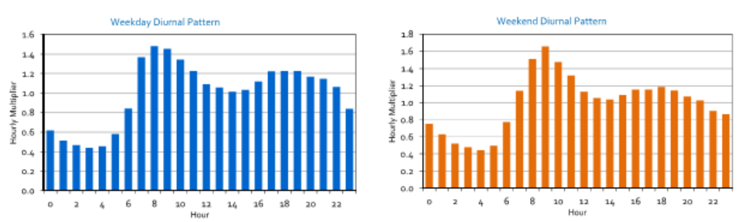


Figure 4.5 Example DWF Calibration Sheet (ASCWD)

4.3.3 Wet Weather Calibration

The wet weather flow (WWF) calibration enables the hydraulic model to accurately simulate inflow and infiltration (I/I) entering the collection system during a large storm event. As outlined below, the WWF calibration process consists of several elements:

- Identify calibration rainfall events. For this project, the WWF calibration process consists of running model simulations of a historic rainfall event. The goal of any WWF calibration is to capture and characterize a system's response to a significant rainfall event, preferably during wet antecedent moisture conditions. For this project, the hydraulic model was calibrated against the storm events that occurred during the period of January and February 2017.

- Define RDII tributary areas. For the WWF calibration, RDII flows are superimposed on top of the DWF. The model calculates RDII by assigning "RDII Inflows" to each node in the model. RDII inflows consist of both a unit hydrograph and the total area that is tributary to the model node. The RDII tributary areas were estimated based on the approximate service area boundary for each service area. The tributary area provides a means to transform hourly rainfall depth from the rainfall hyetographs into a rainfall volume. The rainfall volume is transformed into actual RDII flows using the unit hydrograph, as described in the next step.
- Create I/I parameter database and modify to match field measured flows. The main step in the WWF calibration process involved creating a custom unit hydrograph for the study area using the "RTK Method," which is widely used in collection system master planning. Using the RTK Method, the RDII unit hydrograph is the summation of three separate triangular hydrographs (short term, medium term, and long term), which are each defined by three parameters: R, T, and K. R represents the fraction of rainfall over the sewer basin that enters the collection system; T represents the time to peak of the hydrograph; and K represents the ratio of time to recession to the time to peak. Therefore, there are a total of nine separate variables associated with a unit hydrograph. Figure 4.6 shows the shape of an example unit hydrograph.

The hydrograph utilizes the R-values (percent of rainfall that enters the collection system) calculated for each basin to simulate I/I. The nine variables in each unit hydrograph were initially set based on engineering judgment and then adjusted until the model simulated flows (both peak flows and average flows) matched closely with the field measured flows.

As with the dry weather calibration, the wet weather calibration process compared the measured flow data with the model output. Comparisons were made for average and peak flows as well as the temporal distribution of flow until flows returned to their baseline levels.

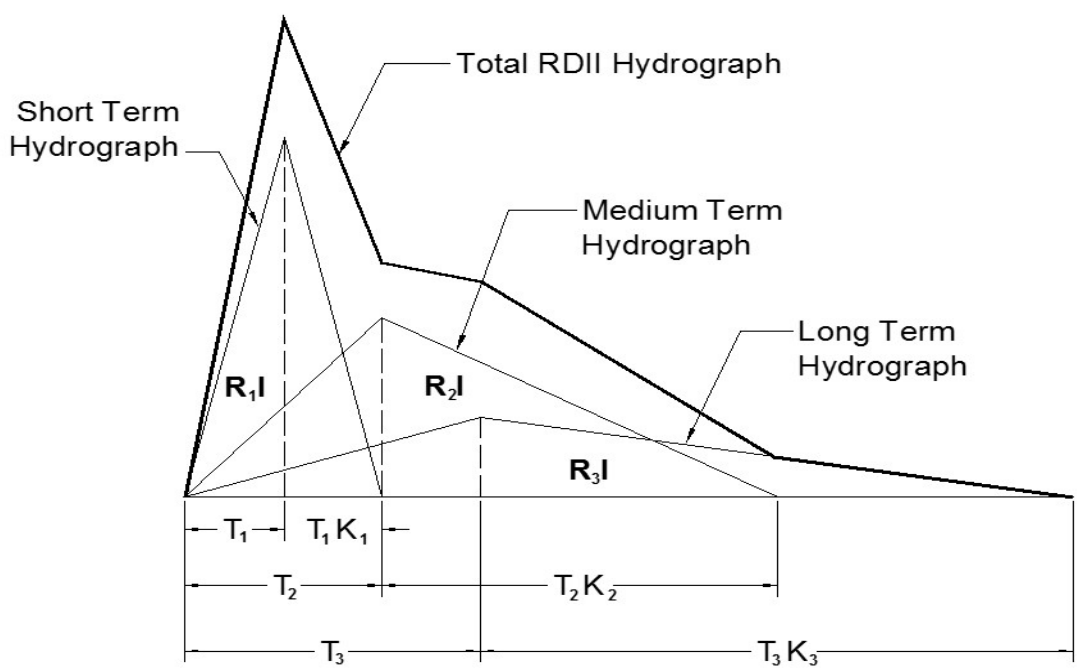


Figure 4.6 Example RDII Unit Hydrograph

Figure 4.7 is an example WWF calibration sheet for the ASCWD flowmeter. The WWF calibration sheets show figures comparing the measured data and model results. The WWF calibration sheets are included in Appendix 4B. In general, there is good correlation between the model simulated flows and the flows that were measured at each meter location. However, the West Shore (Tahoe City Public Utility District) wet weather flow calibration results show a discrepancy between the majority of the measured and modeled data, which is due to inaccuracies in the flow meter data during the selected time period. A notable finding from the wet weather calibration is that the measured flowmeter data contained periods of questionable or missing data. In these cases, an attempt was made in the model to simulate flows as they most likely existed in the field.

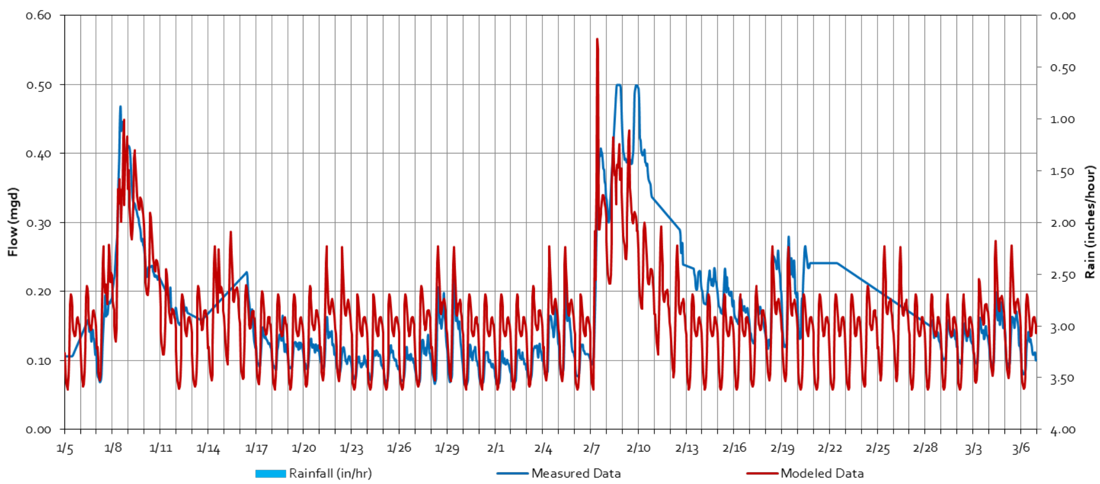


Figure 4.7 Example WWF Calibration Sheet (ASCWD)

4.3.4 Collection System Hydraulic Model Calibration Summary

In summary, the calibration results indicate the model predicts conditions similar to those observed in the field. Within a few isolated areas of the model, there are some very minor discrepancies, but the overall collection system is very well represented in the model.

Based on the results presented in this chapter, it can be concluded that the model is calibrated to dry and wet weather flow conditions. The model provides an accurate representation of T-TSA's collection system to a level suitable for this Master Sewer Plan and for T-TSA's future hydraulic modeling needs.

Appendix 4A

DRY WEATHER FLOW CALIBRATION PLOTS

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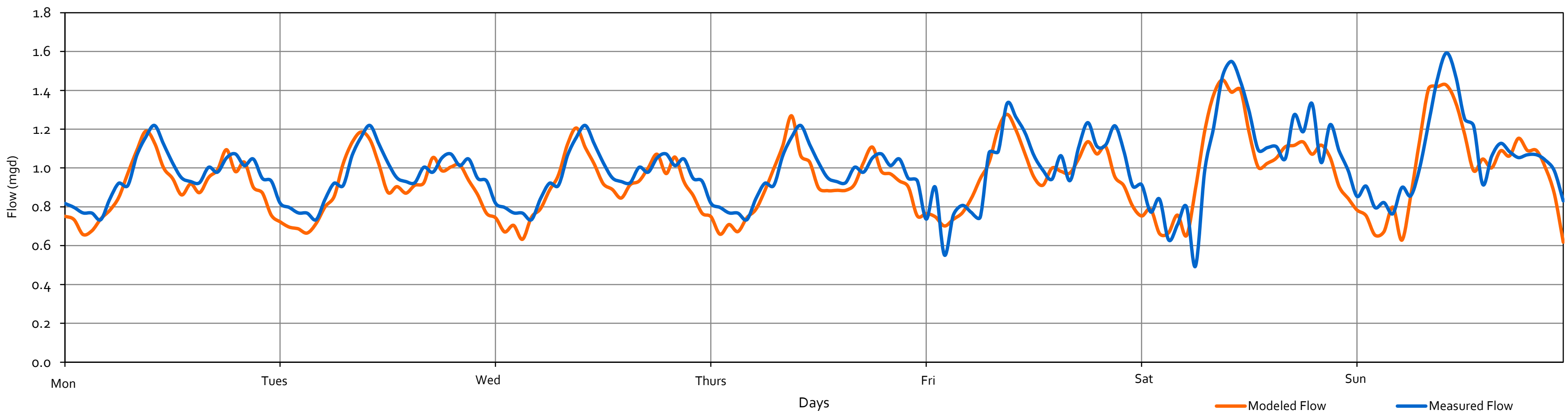
Dollar Hill (NTPUD) Flow Monitoring Site, Dry Weather Flow Calibration

Pipeline Diameter: 21"

Model Pipe ID: LINK_DH_DISCHARGE_LD_NS

Flow Calibration



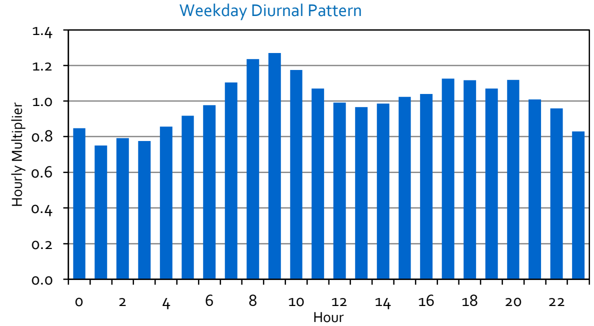
Model Calibration Summary

Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	0.96	1.22	0.91	1.19	-5.4%	-2.5%
Tues.	0.96	1.22	0.91	1.19	-5.4%	-2.7%
Wed.	0.96	1.22	0.91	1.21	-5.5%	-1.1%
Thur.	0.96	1.22	0.91	1.27	-5.1%	4.0%
Fri.	1.00	1.33	0.96	1.28	-3.6%	-4.2%
Sat.	1.07	1.55	1.02	1.45	-3.9%	-6.1%
Sun.	1.06	1.59	1.00	1.43	-5.2%	-10.5%
Summary						
Weekday	0.97	--	0.92	--	-5.0%	--
Weekend	1.06	--	1.01	--	-4.5%	--
ADWF[4]	0.99	--	0.95	--	-4.8%	--

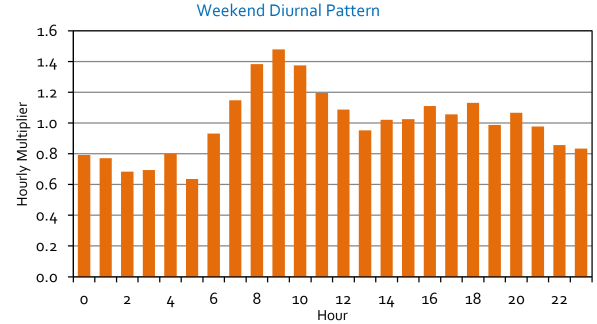
Notes:

1. Source: T-TSA Hourly Flow Meter Data
2. Peak flow is the hourly average hourly peak flow.
3. Percent Error = (Modeled - Measured) /Measured x 100
4. ADWF = (5xWeekday Average + 2xWeekend Average)/7

Weekday Diurnal Pattern

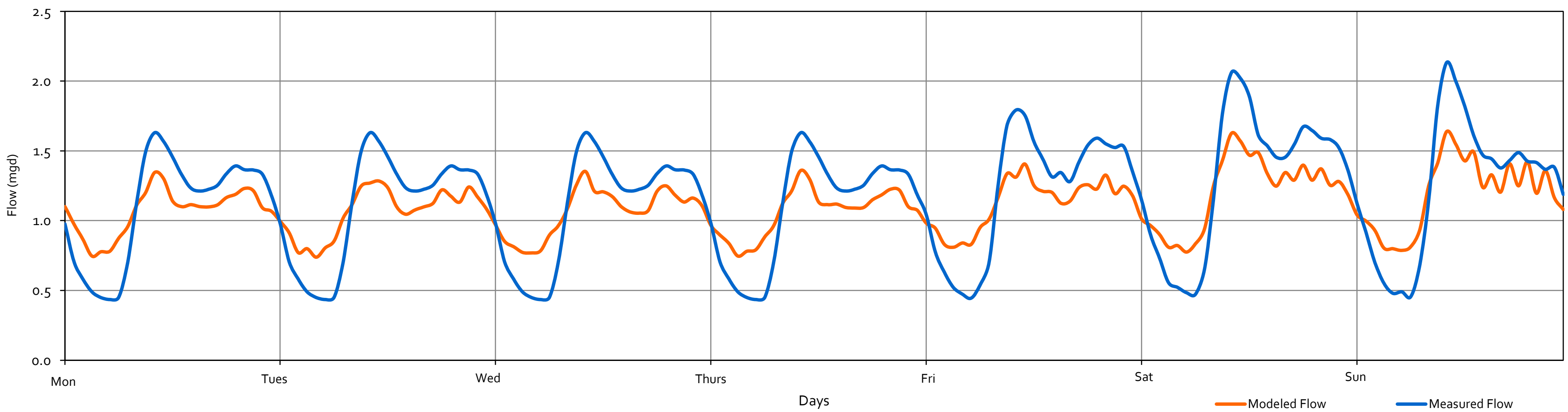


Weekend Diurnal Pattern



North Shore (TCPUD/NTPUD) Flow Monitoring Site, Dry Weather Flow Calibration
Pipeline Diameter: 42"
Model Pipe ID: LINK_1_2

Flow Calibration

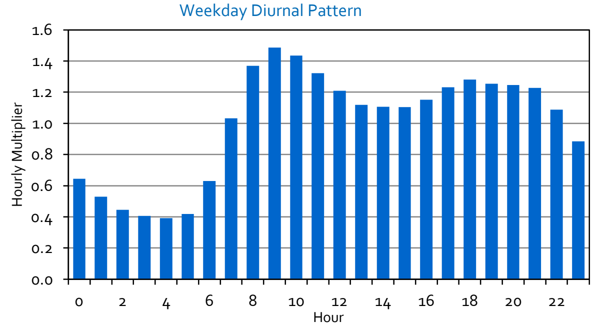


Model Calibration Summary

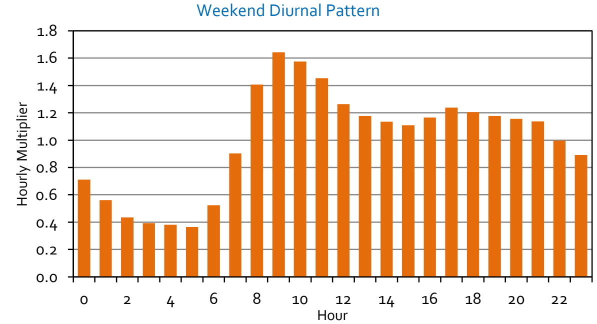
Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	1.10	1.63	1.07	1.35	-2.4%	-17.5%
Tues.	1.10	1.63	1.06	1.29	-3.0%	-21.2%
Wed.	1.10	1.63	1.06	1.35	-3.3%	-17.0%
Thur.	1.10	1.63	1.06	1.36	-3.2%	-16.7%
Fri.	1.21	1.79	1.13	1.41	-7.1%	-21.5%
Sat.	1.31	2.06	1.20	1.63	-7.8%	-21.1%
Sun.	1.25	2.13	1.19	1.64	-4.7%	-23.2%
Summary						
Weekday	1.12	--	1.08	--	-3.9%	--
Weekend	1.28	--	1.20	--	-6.3%	--
ADWF[4]	1.16	--	1.11	--	-4.6%	--

Notes:
1. Source: T-TSA Hourly Flow Meter Data
2. Peak flow is the hourly average hourly peak flow.
3. Percent Error = (Modeled - Measured) /Measured x 100
4. ADWF = (5xWeekday Average + 2xWeekend Average)/7

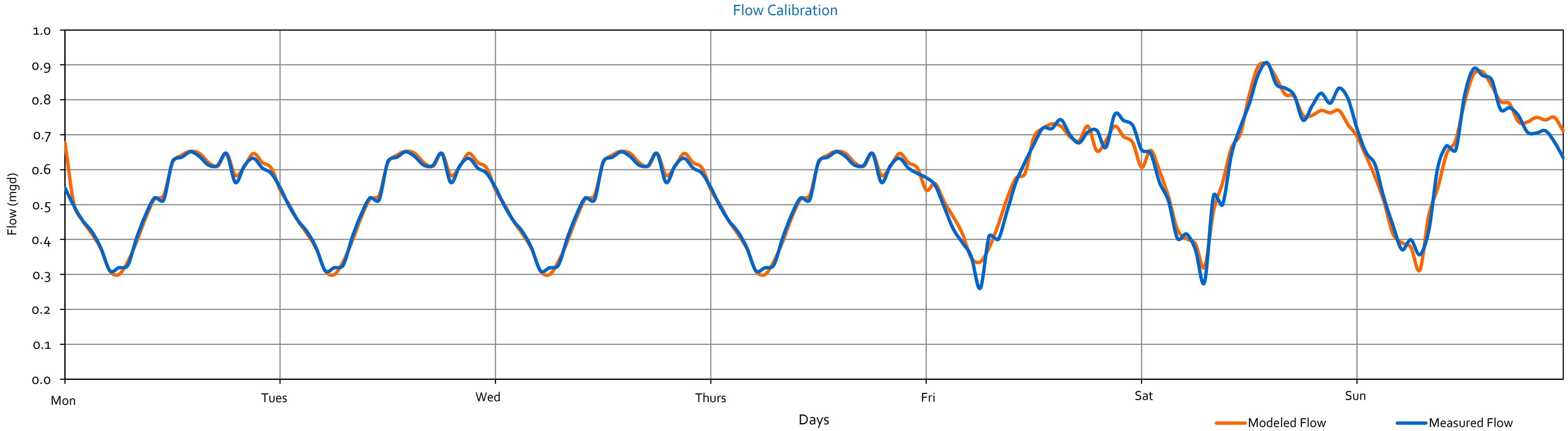
Weekday Diurnal Pattern



Weekend Diurnal Pattern



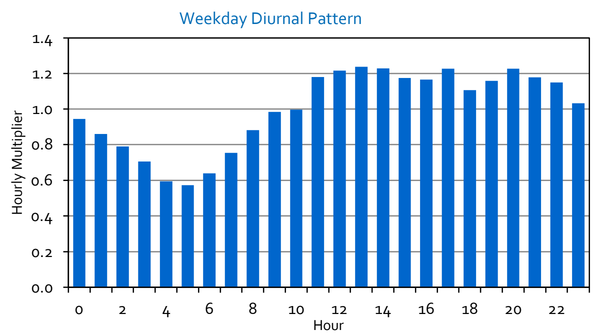
West Shore (TCPUD) Flow Monitoring Site, Dry Weather Flow Calibration
Pipeline Diameter: 24"
Model Pipe ID: LINK_LD_WS_2

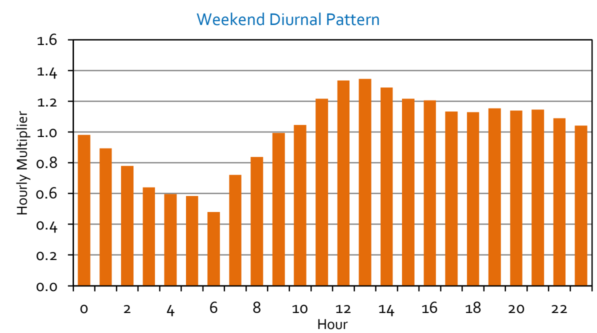


Model Calibration Summary

Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	0.52	0.65	0.53	0.68	1.5%	4.1%
Tues.	0.52	0.65	0.53	0.65	0.4%	0.3%
Wed.	0.52	0.65	0.53	0.65	0.4%	0.3%
Thur.	0.52	0.65	0.53	0.65	0.4%	0.3%
Fri.	0.59	0.76	0.59	0.73	0.1%	-3.7%
Sat.	0.67	0.91	0.67	0.90	-0.6%	-0.4%
Sun.	0.65	0.89	0.65	0.88	0.4%	-1.1%
Summary						
Weekday	0.54	--	0.54	--	0.5%	--
Weekend	0.66	--	0.66	--	-0.1%	--
ADWF[4]	0.57	--	0.57	--	0.3%	--

Notes:
1. Source: T-TSA Hourly Flow Meter Data
2. Peak flow is the hourly average hourly peak flow.
3. Percent Error = (Modeled - Measured) /Measured x 100
4. ADWF = (5xWeekday Average + 2xWeekend Average)/7

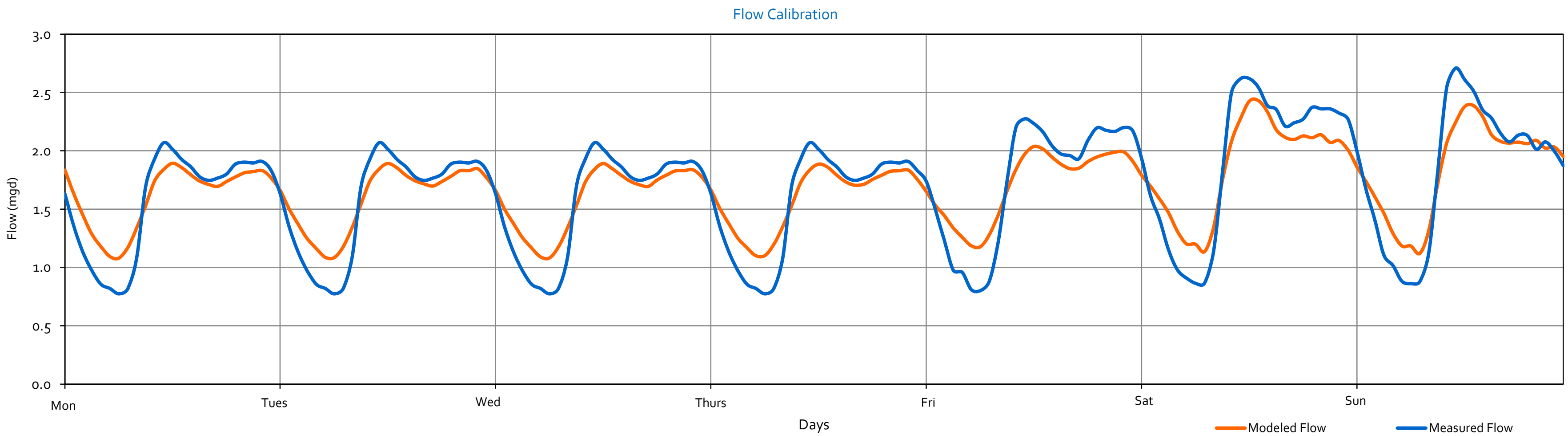




Rampart Flow Monitoring Site, Dry Weather Flow Calibration

Pipeline Diameter: 30"

Model Pipe ID: LINK_11_12

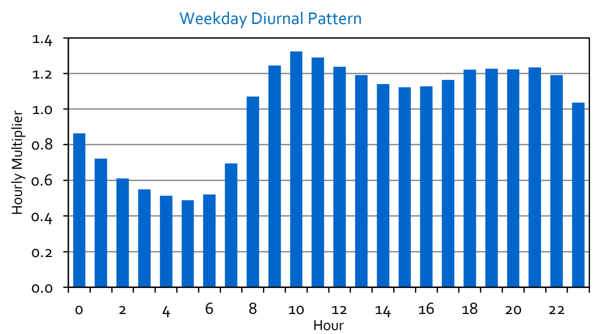


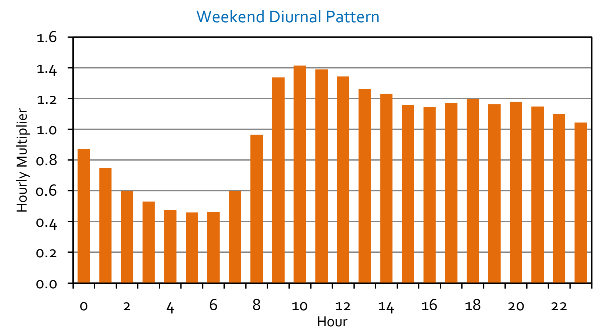
Model Calibration Summary

Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	1.56	2.07	1.61	1.89	3.1%	-8.6%
Tues.	1.56	2.07	1.59	1.89	2.1%	-8.6%
Wed.	1.56	2.07	1.59	1.89	2.1%	-8.6%
Thur.	1.56	2.07	1.60	1.89	2.2%	-8.9%
Fri.	1.74	2.28	1.71	2.04	-1.3%	-10.4%
Sat.	1.92	2.62	1.87	2.43	-2.5%	-7.2%
Sun.	1.84	2.71	1.85	2.39	0.4%	-11.9%
Summary						
Weekday	1.60	--	1.62	--	1.6%	--
Weekend	1.88	--	1.86	--	-1.1%	--
ADWF[4]	1.68	--	1.69	--	0.7%	--

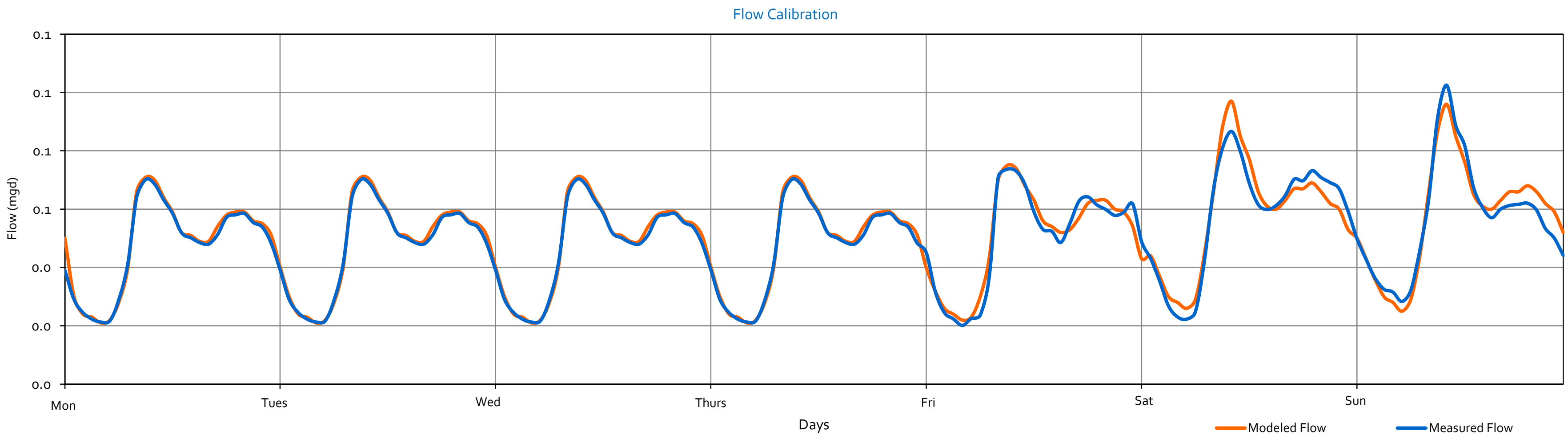
Notes:

1. Source: T-TSA Hourly Flow Meter Data
2. Peak flow is the hourly average hourly peak flow.
3. Percent Error = (Modeled - Measured) /Measured x 100
4. ADWF = (5xWeekday Average + 2xWeekend Average)/7





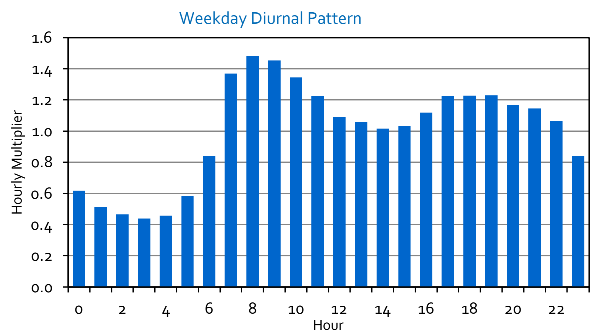
Alpine (ASCWD) Flow Monitoring Site, Dry Weather Flow Calibration
Pipeline Diameter: 24"
Model Pipe ID: LINK_237

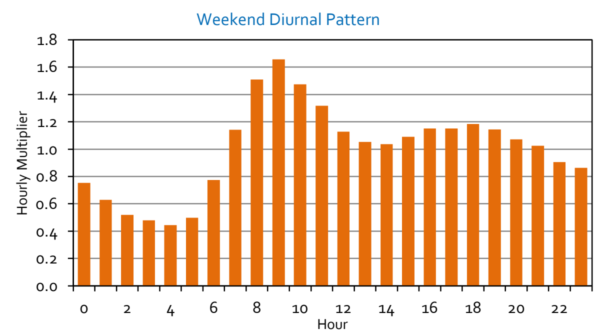


Model Calibration Summary

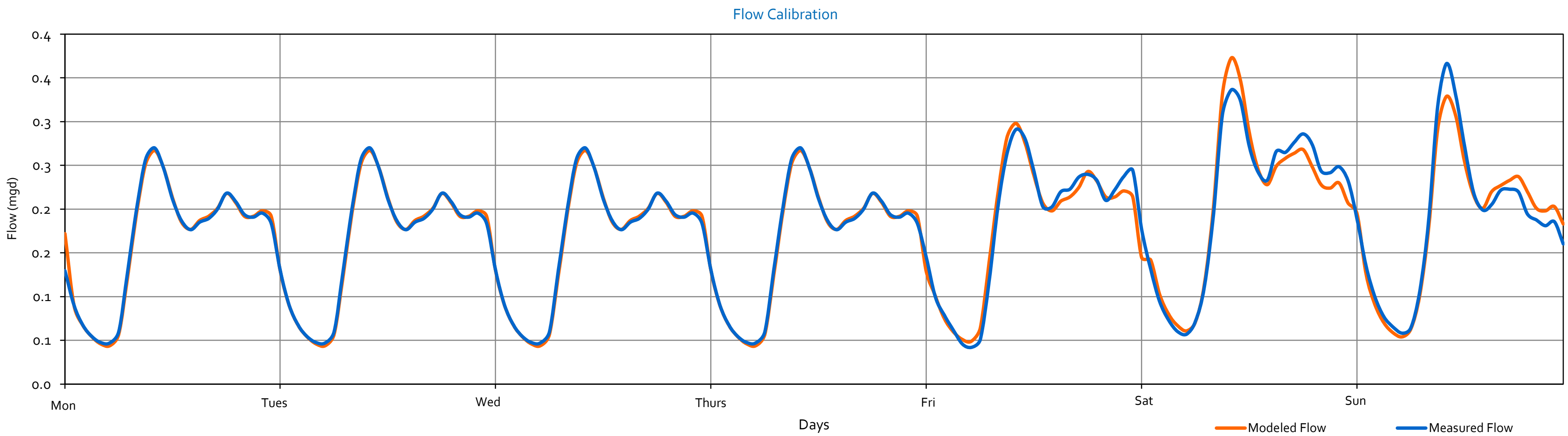
Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	0.05	0.07	0.05	0.07	2.4%	1.2%
Tues.	0.05	0.07	0.05	0.07	1.5%	1.2%
Wed.	0.05	0.07	0.05	0.07	1.5%	1.2%
Thur.	0.05	0.07	0.05	0.07	1.5%	1.2%
Fri.	0.05	0.07	0.05	0.08	1.3%	1.7%
Sat.	0.06	0.09	0.06	0.10	0.9%	11.9%
Sun.	0.06	0.10	0.06	0.10	1.3%	-6.4%
Summary						
Weekday	0.05	--	0.05	--	1.6%	--
Weekend	0.06	--	0.06	--	1.1%	--
ADWF[4]	0.05	--	0.05	--	1.5%	--

Notes:
1. Source: T-TSA Hourly Flow Meter Data
2. Peak flow is the hourly average hourly peak flow.
3. Percent Error = (Modeled - Measured) /Measured x 100
4. ADWF = (5xWeekday Average + 2xWeekend Average)/7





Olympic Valley (OVPSD) Flow Monitoring Site, Dry Weather Flow Calibration
Pipeline Diameter: 24"
Model Pipe ID: LINK_LD_SV_43

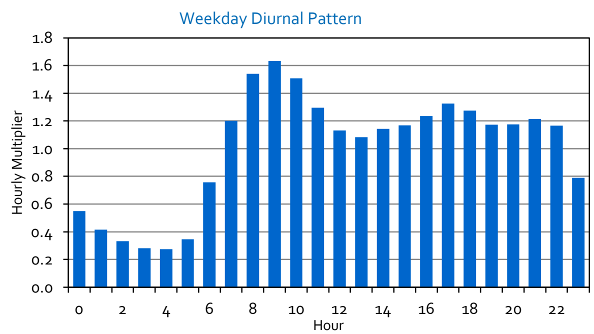


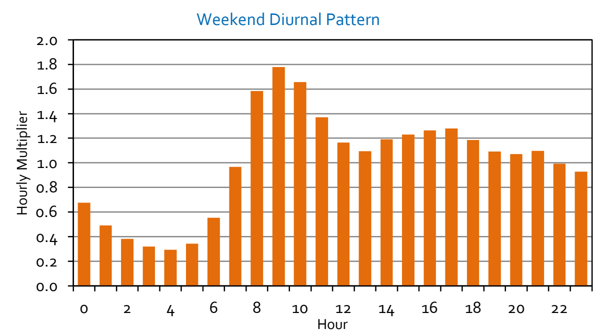
Model Calibration Summary

Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	0.16	0.27	0.17	0.27	0.8%	-1.1%
Tues.	0.16	0.27	0.16	0.27	-0.3%	-1.1%
Wed.	0.16	0.27	0.16	0.27	-0.3%	-1.1%
Thur.	0.16	0.27	0.16	0.27	-0.3%	-1.1%
Fri.	0.18	0.29	0.18	0.30	-0.5%	2.3%
Sat.	0.21	0.34	0.21	0.37	-0.9%	10.8%
Sun.	0.19	0.37	0.19	0.33	-0.1%	-10.3%
Summary						
Weekday	0.17	--	0.17	--	-0.2%	--
Weekend	0.20	--	0.20	--	-0.5%	--
ADWF[4]	0.18	--	0.18	--	-0.3%	--

Notes:

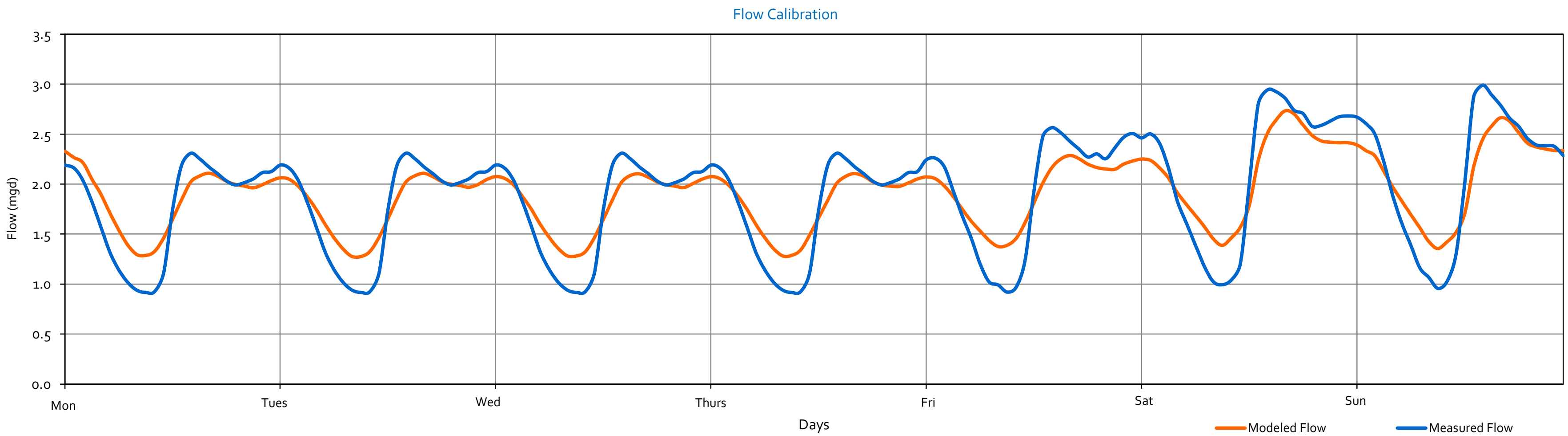
1. Source: T-TSA Hourly Flow Meter Data
2. Peak flow is the hourly average hourly peak flow.
3. Percent Error = (Modeled - Measured) /Measured x 100
4. ADWF = (5xWeekday Average + 2xWeekend Average)/7





Granite Flats Flow Monitoring Site, Dry Weather Flow Calibration

Pipeline Diameter: 27"
Model Pipe ID: LINK_86_87

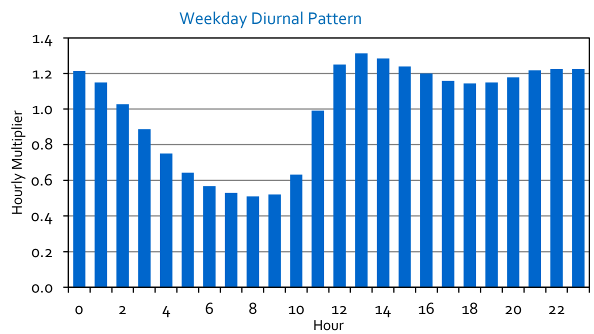


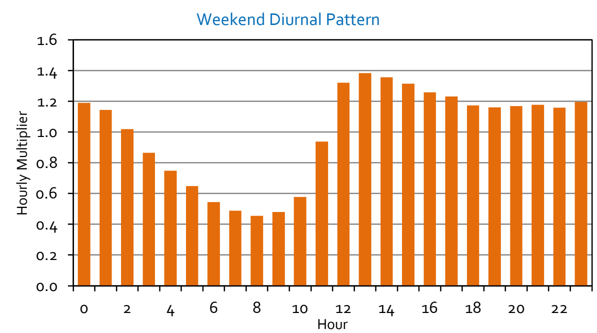
Model Calibration Summary

Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	1.76	2.31	1.86	2.33	5.4%	0.9%
Tues.	1.76	2.31	1.80	2.11	2.4%	-8.6%
Wed.	1.76	2.31	1.80	2.10	2.5%	-8.8%
Thur.	1.76	2.31	1.81	2.11	2.6%	-8.7%
Fri.	1.94	2.57	1.92	2.29	-1.0%	-10.8%
Sat.	2.16	2.94	2.12	2.74	-1.9%	-7.1%
Sun.	2.13	2.99	2.10	2.67	-1.2%	-10.9%
Summary						
Weekday	1.80	--	1.84	--	2.3%	--
Weekend	2.15	--	2.11	--	-1.6%	--
ADWF[4]	1.90	--	1.92	--	1.1%	--

Notes:

1. Source: T-TSA Hourly Flow Meter Data
2. Peak flow is the hourly average hourly peak flow.
3. Percent Error = (Modeled - Measured) /Measured x 100
4. ADWF = (5xWeekday Average + 2xWeekend Average)/7

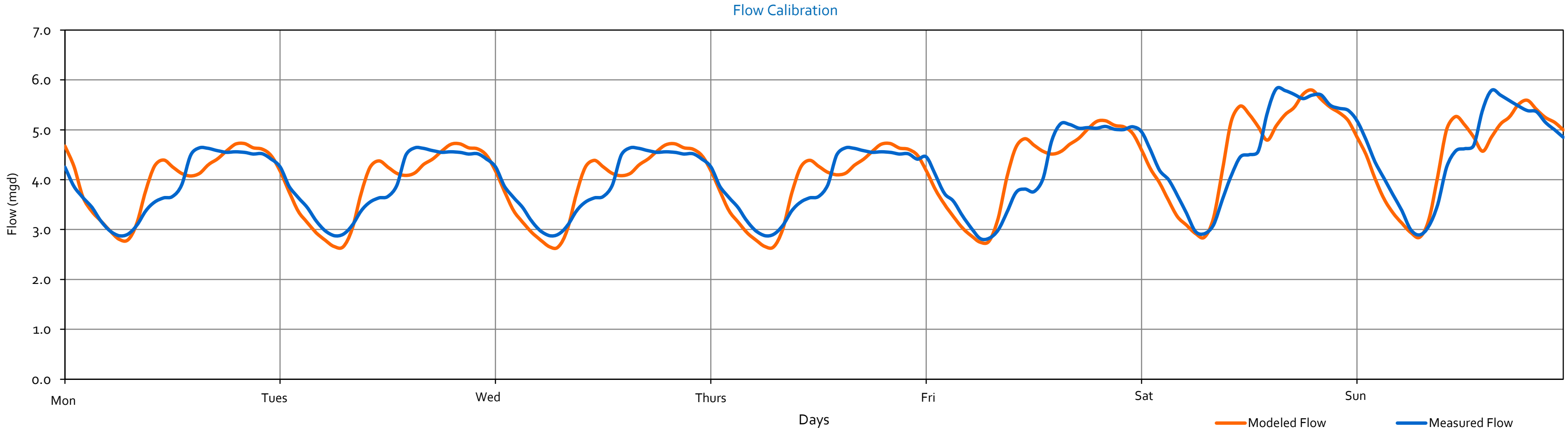




Plant Influent (WRP) Flow Monitoring Site, Dry Weather Flow Calibration

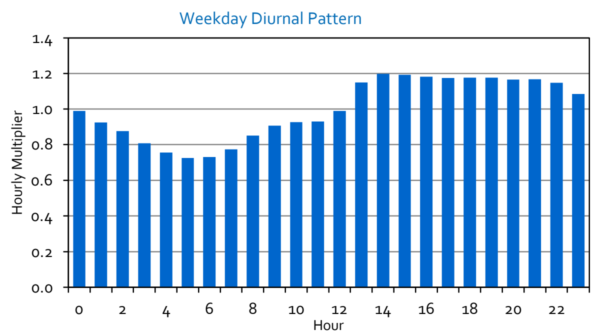
Pipeline Diameter: 36"

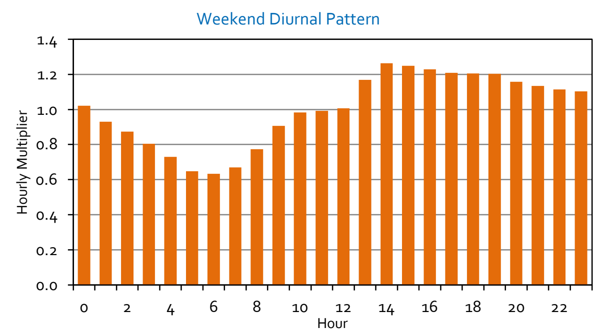
Model Pipe ID: LINK_HEADWORKS_DUMMY_HW



Model Calibration Summary

Day	Measured Data[1] Avg. Flow (mgd)	Measured Data[1] Peak Flow[2] (mgd)	Modeled Data Avg. Flow (mgd)	Modeled Data Peak Flow[2] (mgd)	Percent Error[3] Avg. Flow (%)	Percent Error[3] Peak Flow (%)
Mon.	3.91	4.64	4.01	4.73	2.7%	1.8%
Tues.	3.91	4.64	3.91	4.72	0.1%	1.7%
Wed.	3.91	4.64	3.91	4.72	0.1%	1.7%
Thur.	3.91	4.64	3.92	4.72	0.2%	1.8%
Fri.	4.16	5.12	4.22	5.18	1.5%	1.1%
Sat.	4.62	5.82	4.61	5.80	-0.3%	-0.4%
Sun.	4.57	5.79	4.52	5.59	-1.2%	-3.5%
Summary						
Weekday	3.96	--	4.00	--	0.9%	--
Weekend	4.60	--	4.57	--	-0.7%	--
ADWF[4]	4.14	--	4.16	--	0.4%	--





Notes:

1. Source: T-TSA Hourly Flow Meter Data
2. Peak flow is the hourly average hourly peak flow.
3. Percent Error = (Modeled - Measured) /Measured x 100
4. ADWF = (5xWeekday Average + 2xWeekend Average)/7

Appendix 4B

WET WEATHER FLOW CALIBRATION PLOTS

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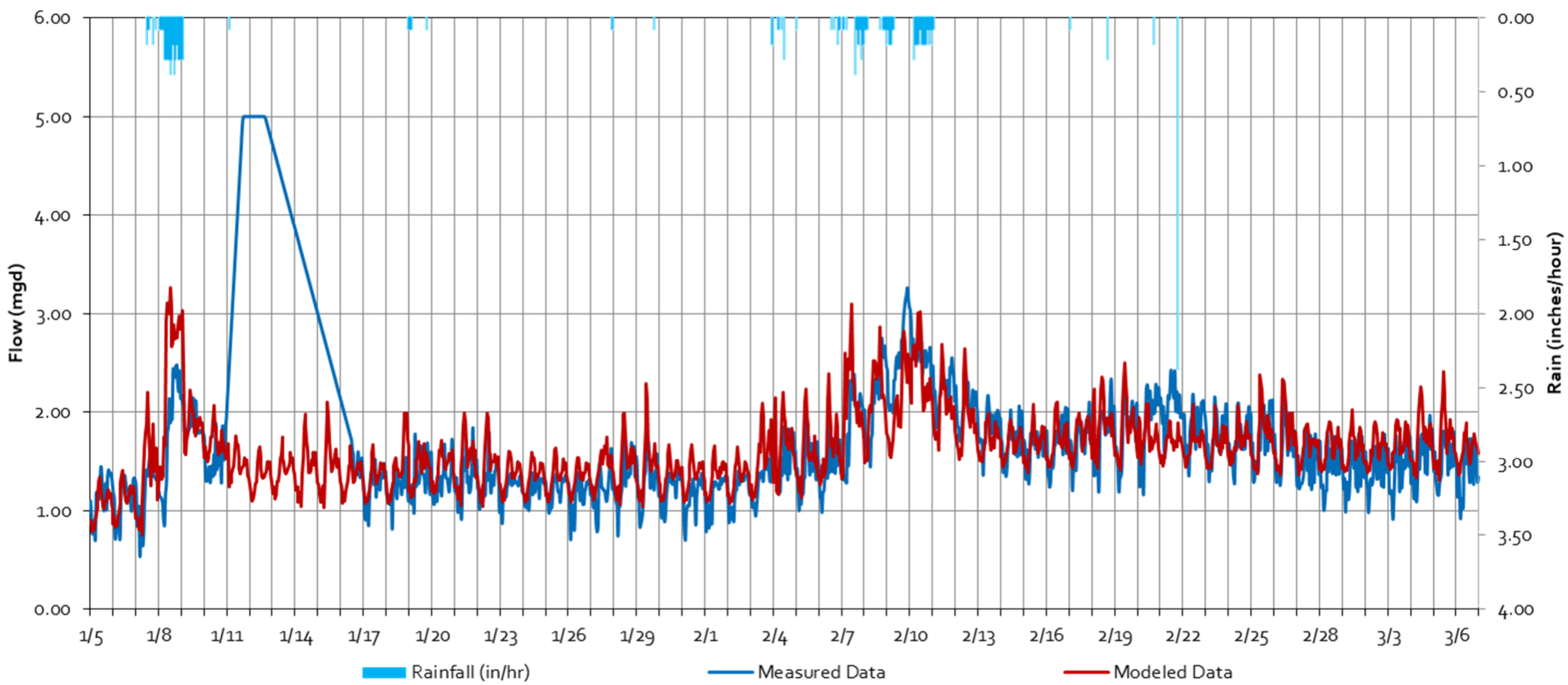
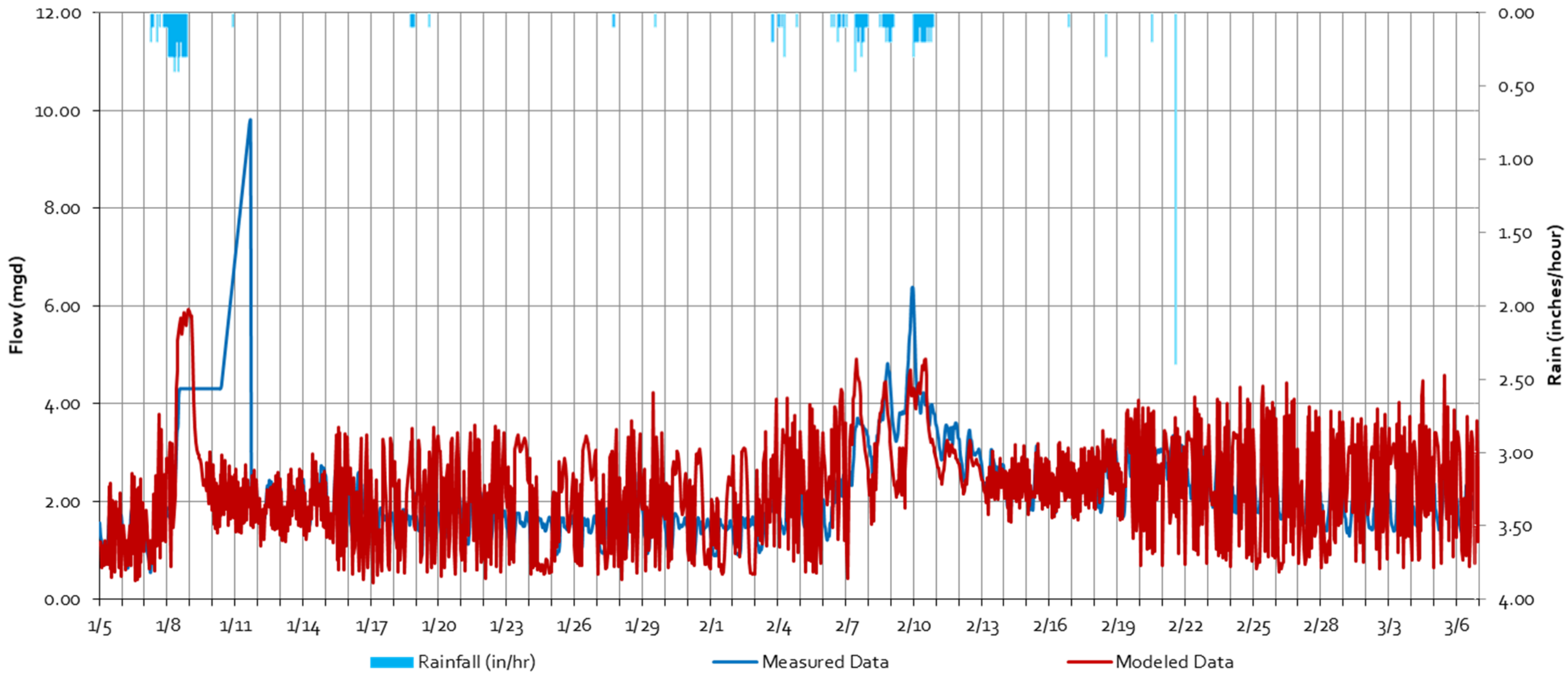
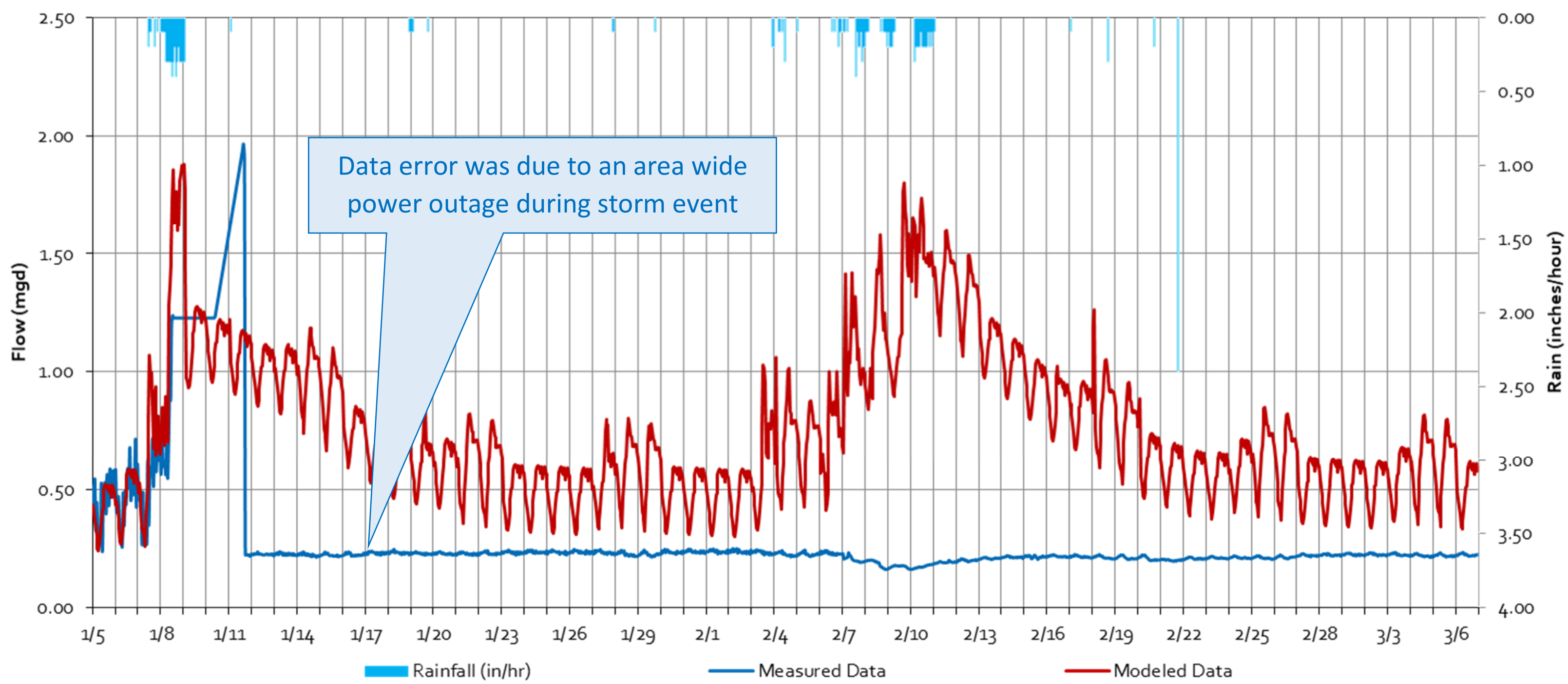
Dollar Hill (NTPUD) wet weather flow calibration results



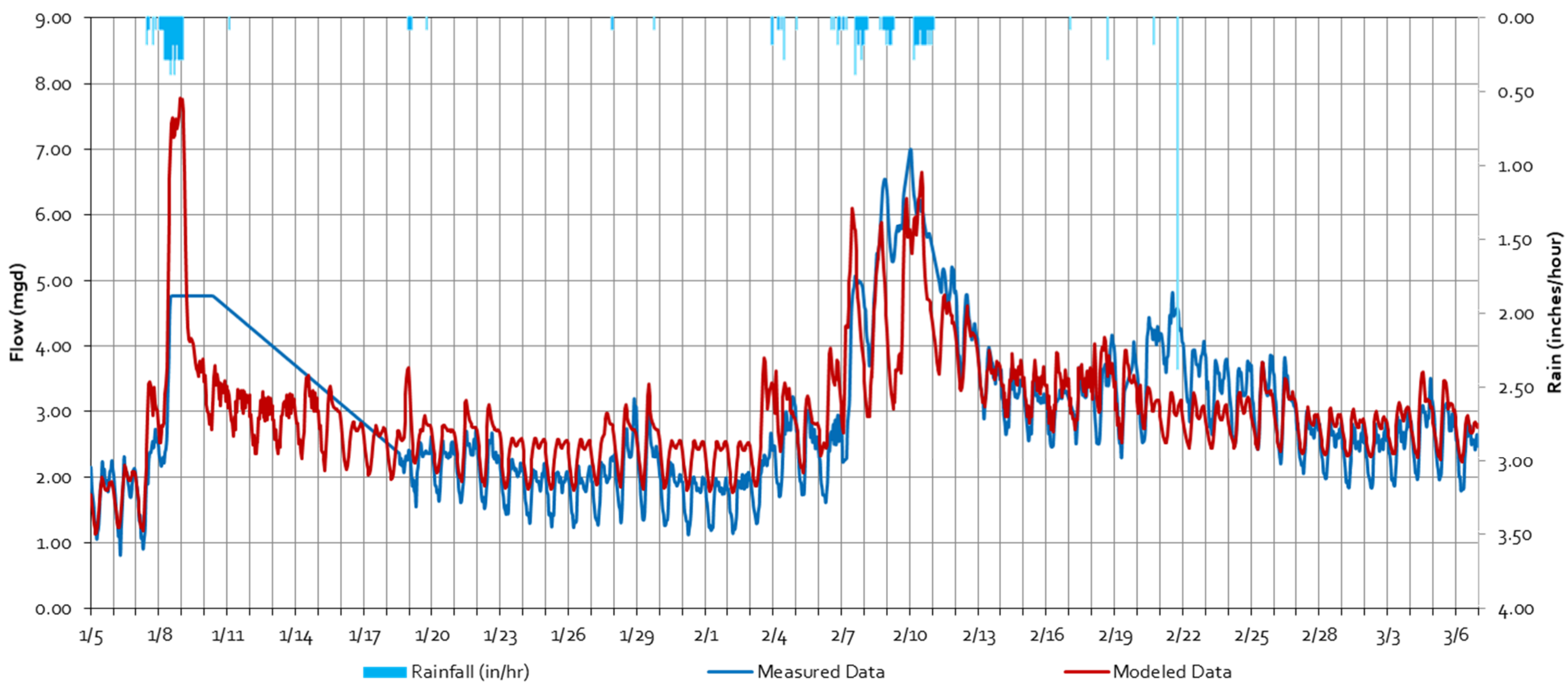
North Shore (TCPUD/NTPUD) wet weather flow calibration results



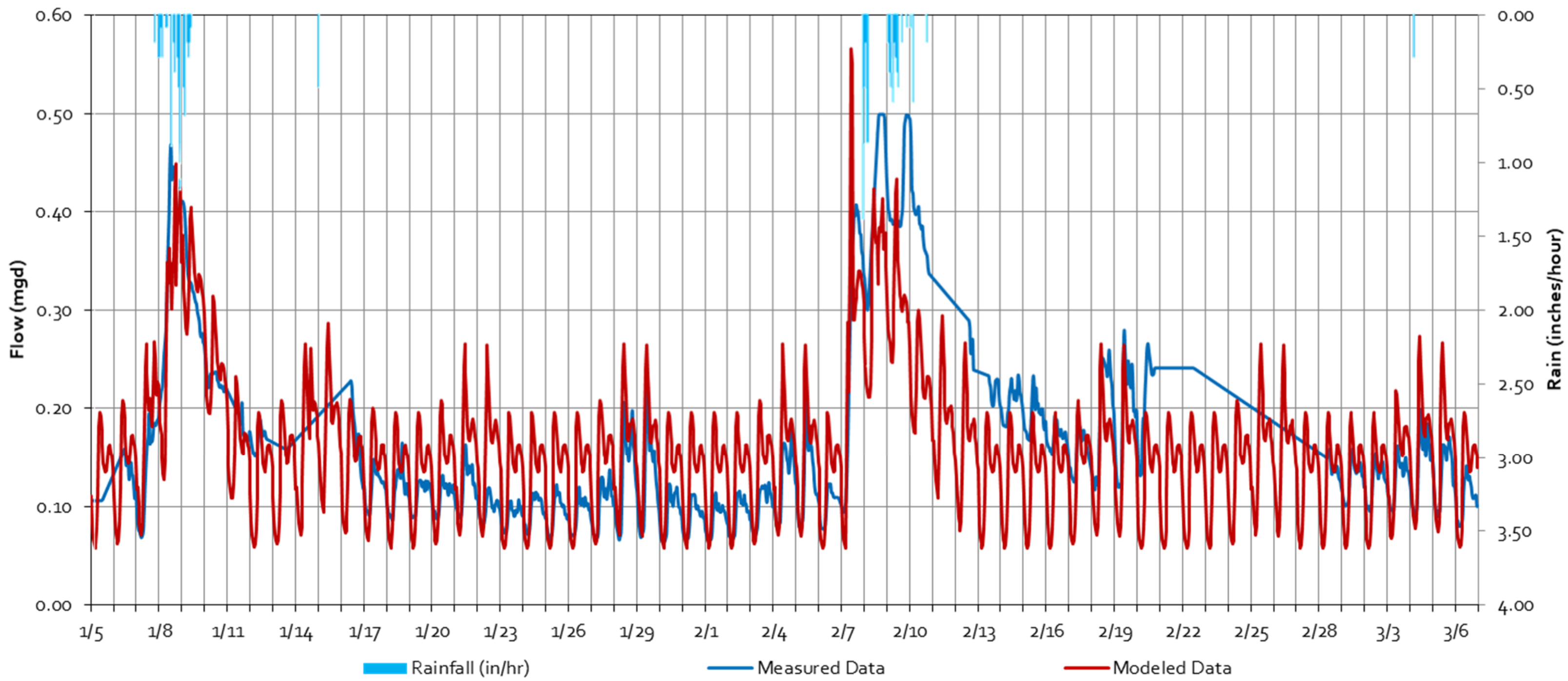
West Shore (TCPUD) wet weather flow calibration results



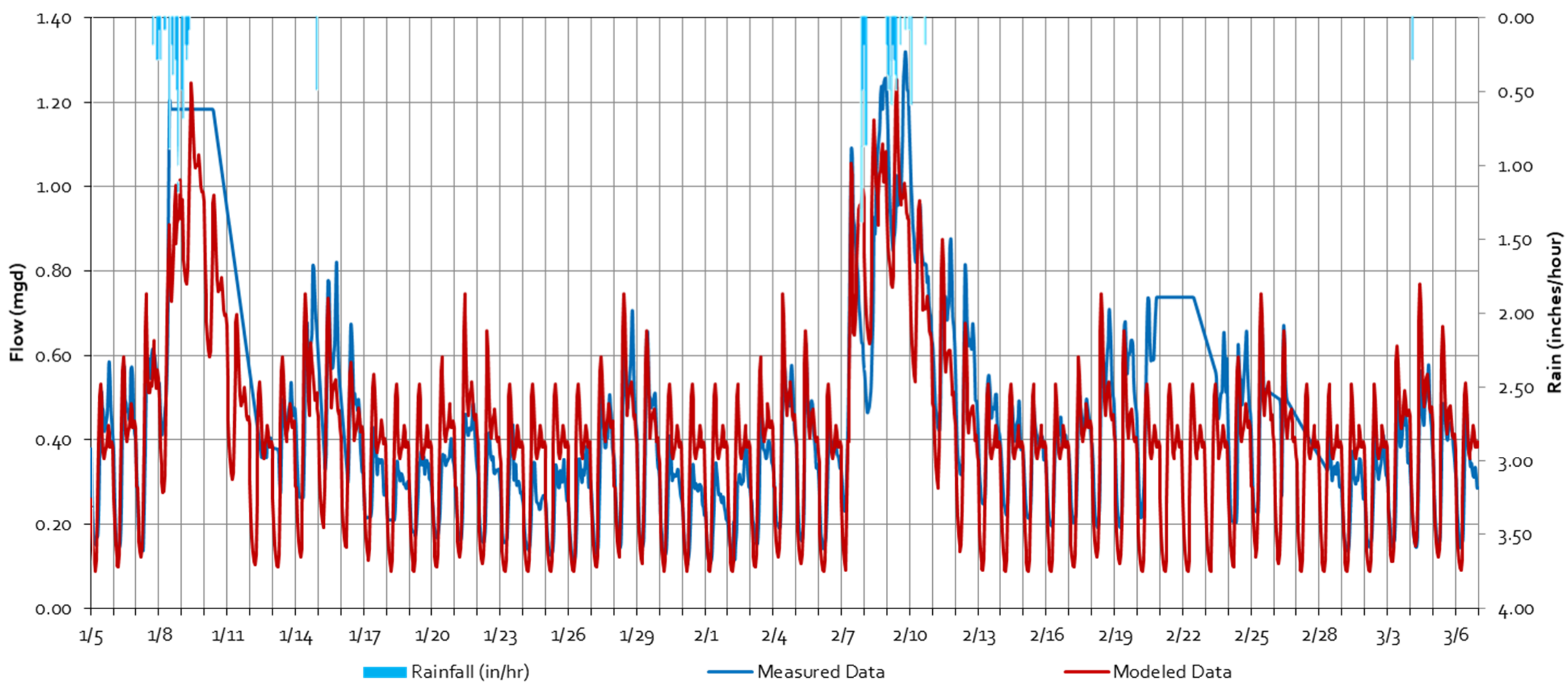
Rampart wet weather flow calibration results



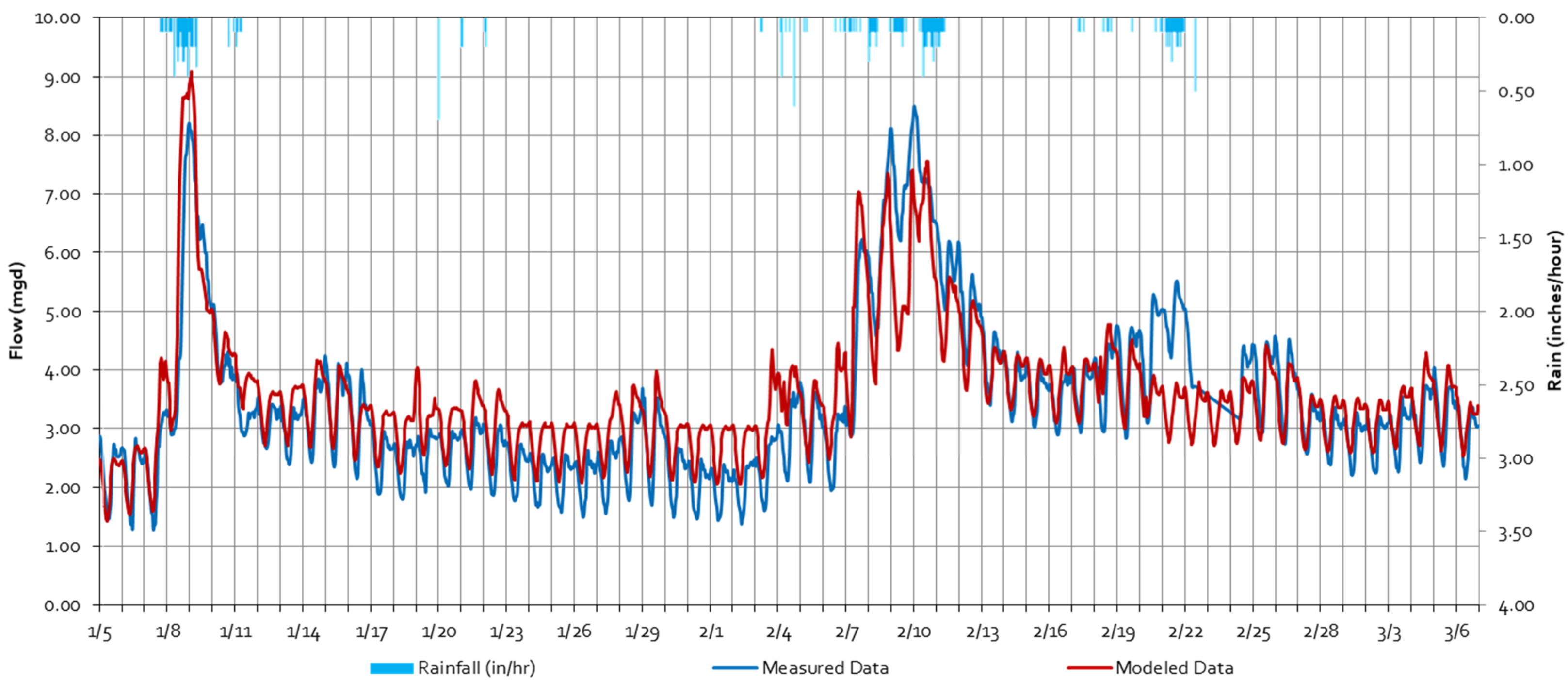
Alpine (ASCWD) wet weather flow calibration results



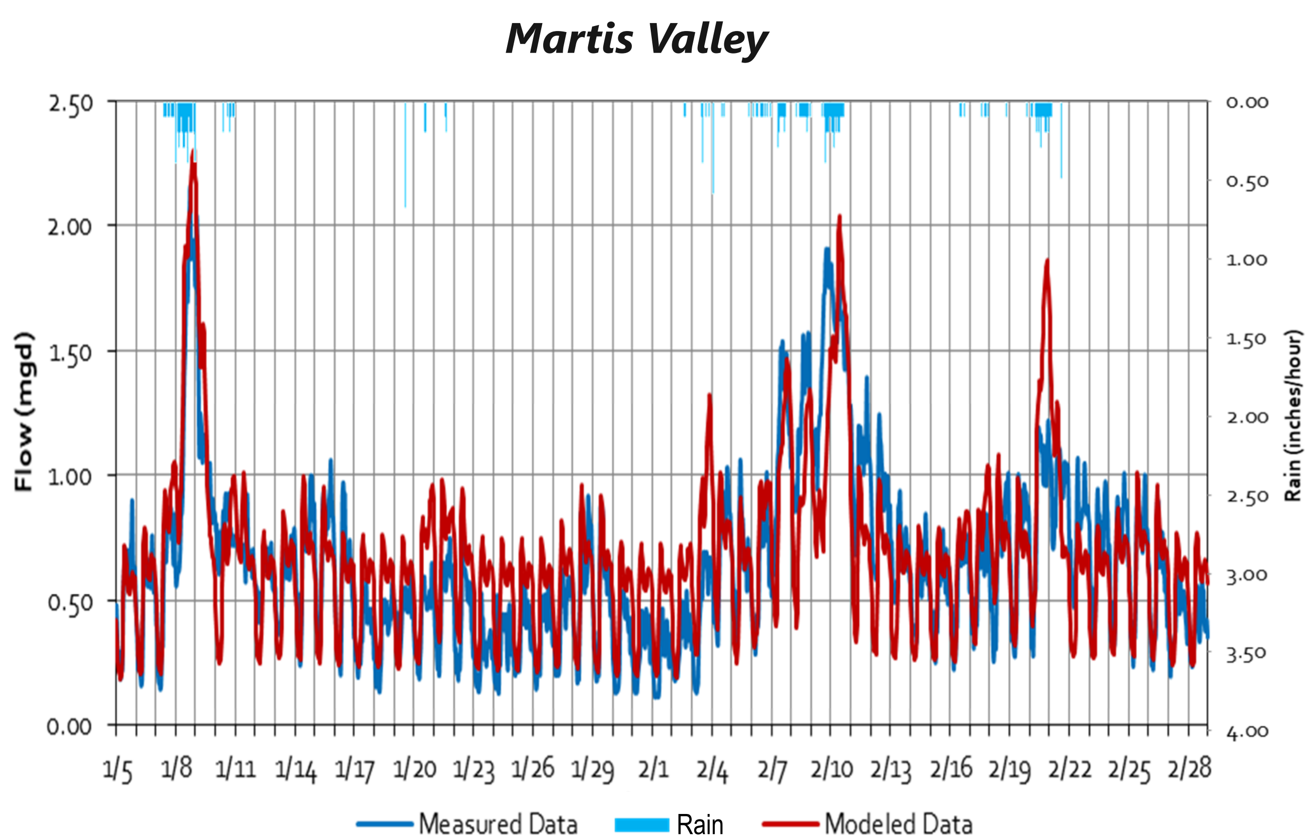
Olympic Valley (OVPSD) wet weather flow calibration results



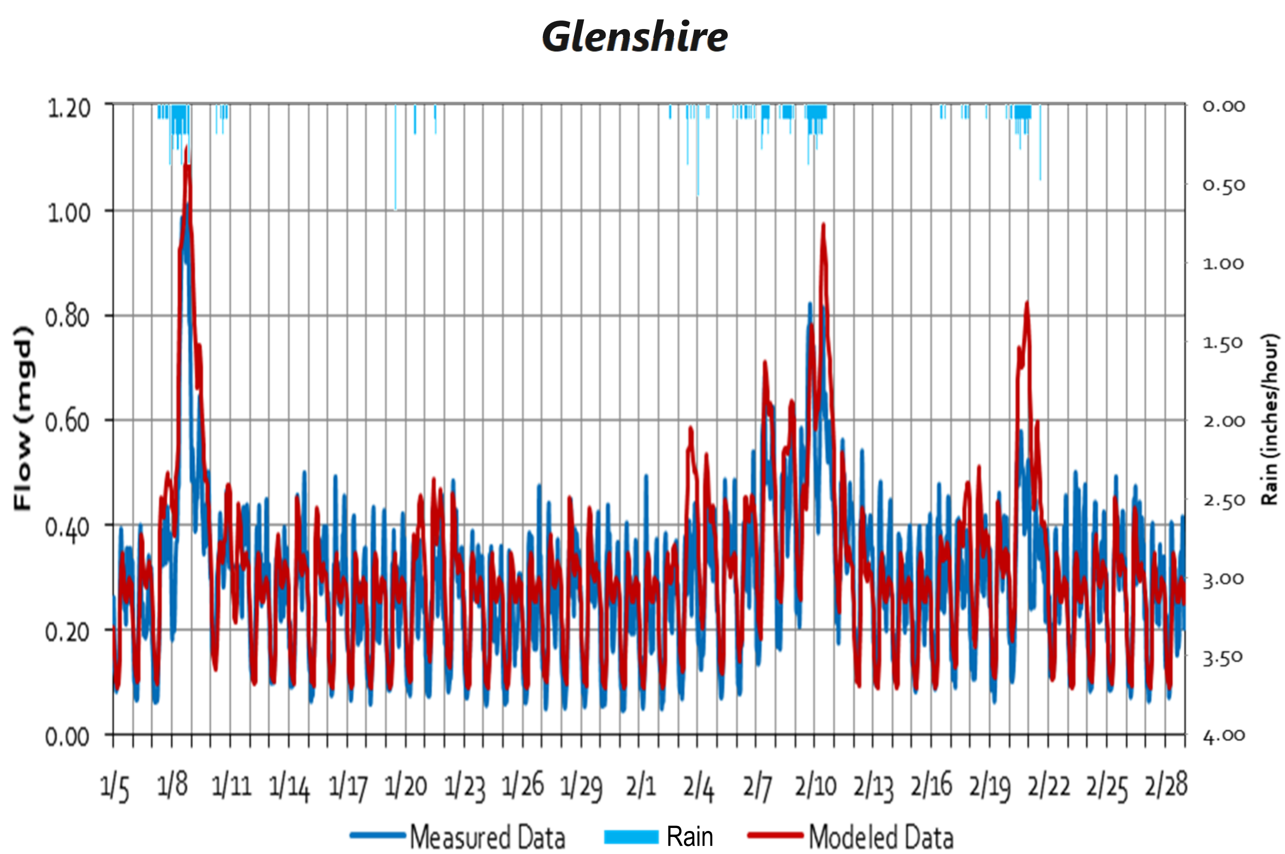
Granite Flats wet weather flow calibration results



Truckee Sanitary District (TSD) flow meter data used to verify flow per connection from the District

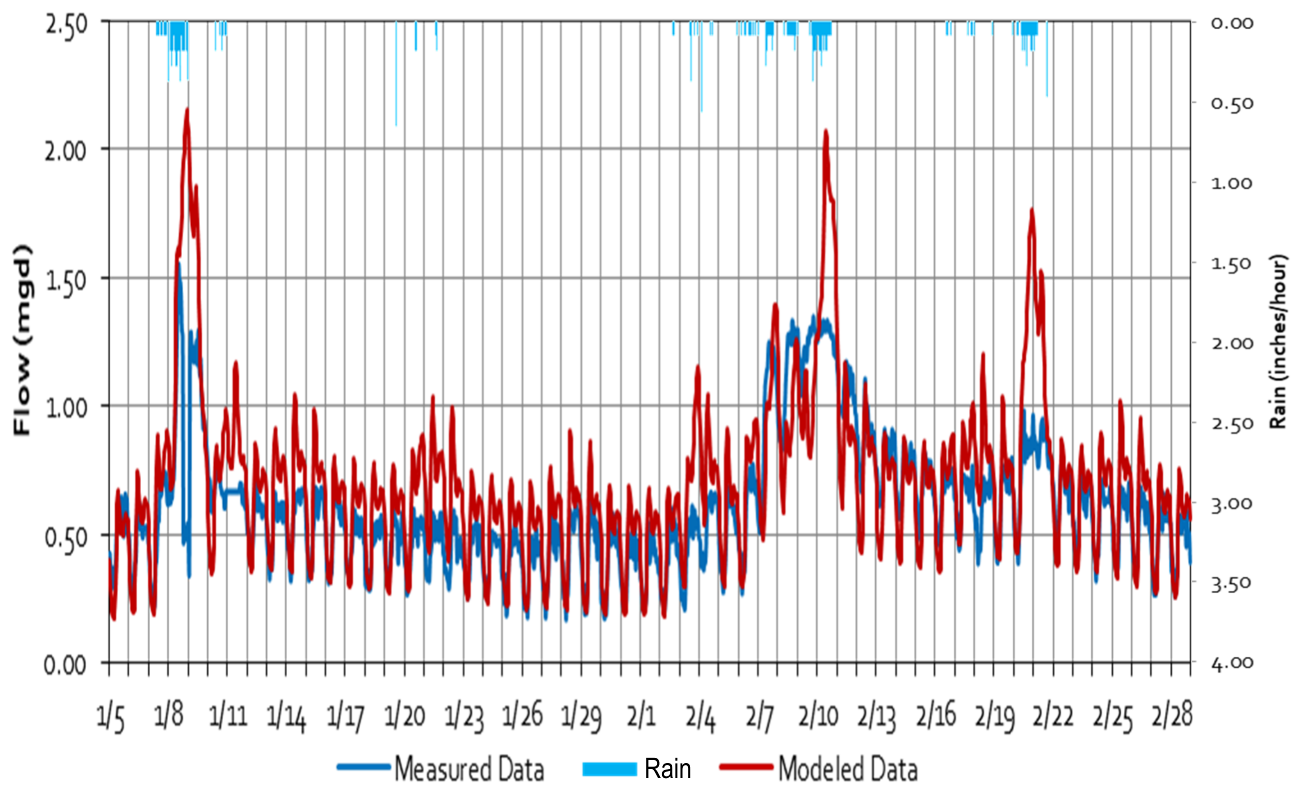


TSD flow meter verification (continued)

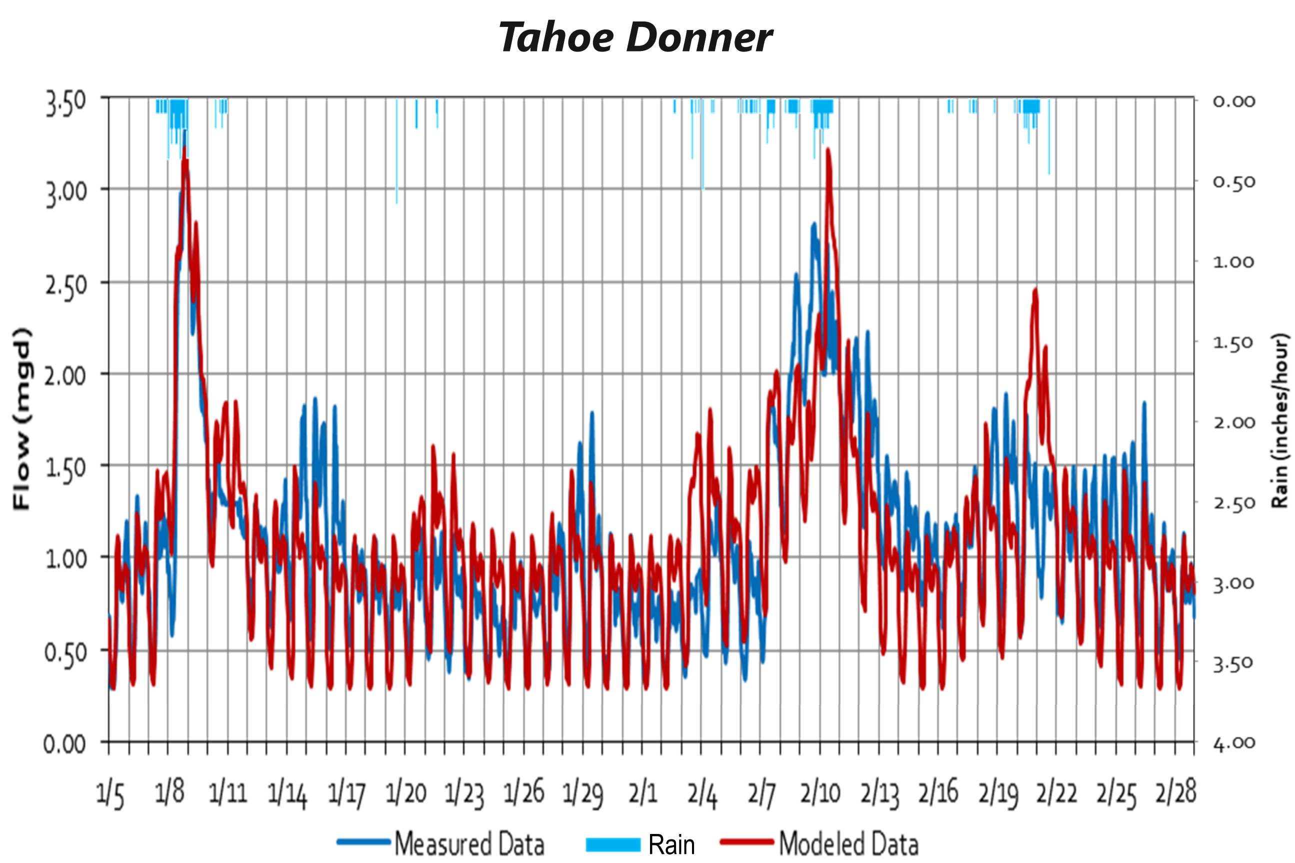


TSD flow meter verification (continued)

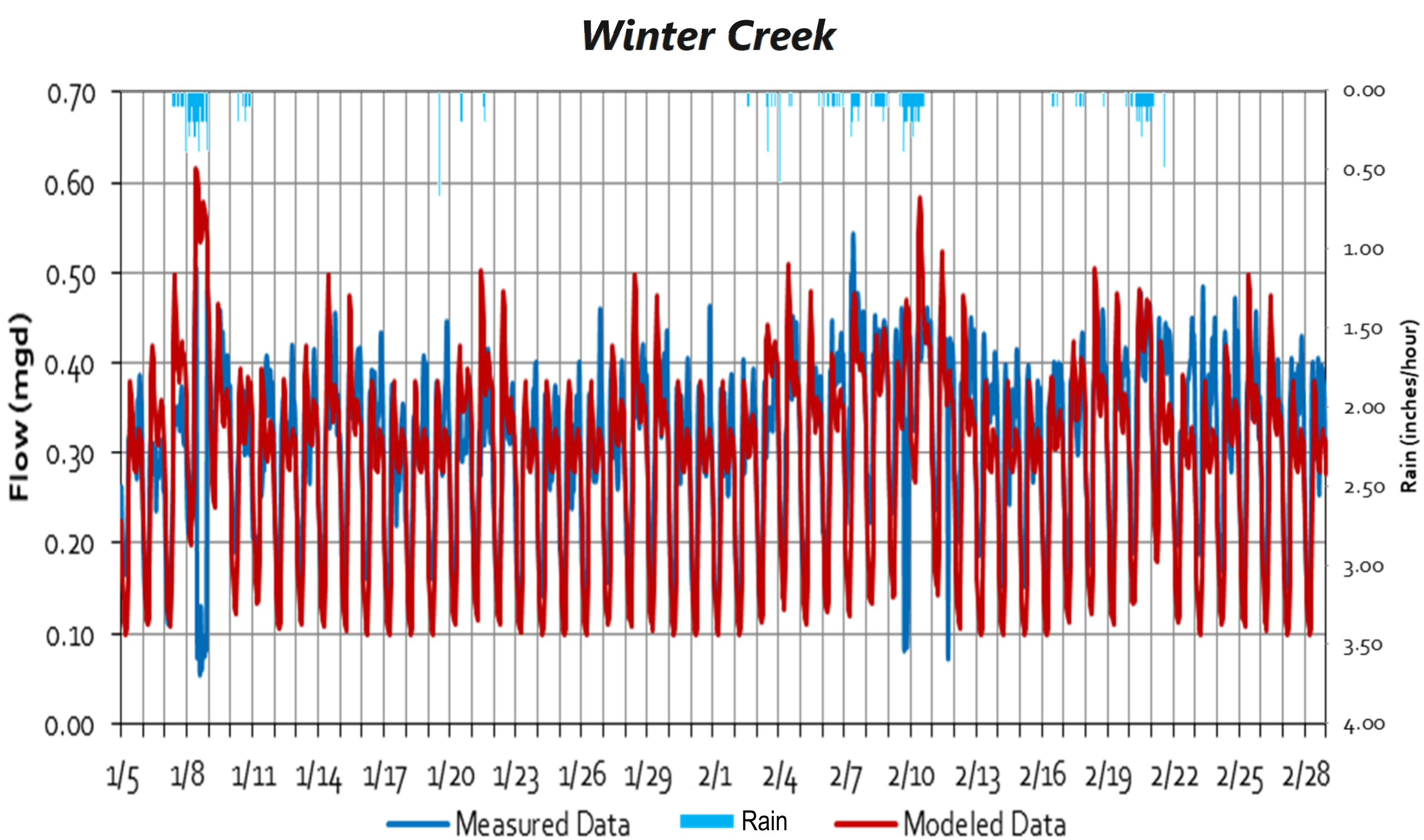
Tahoe Donner



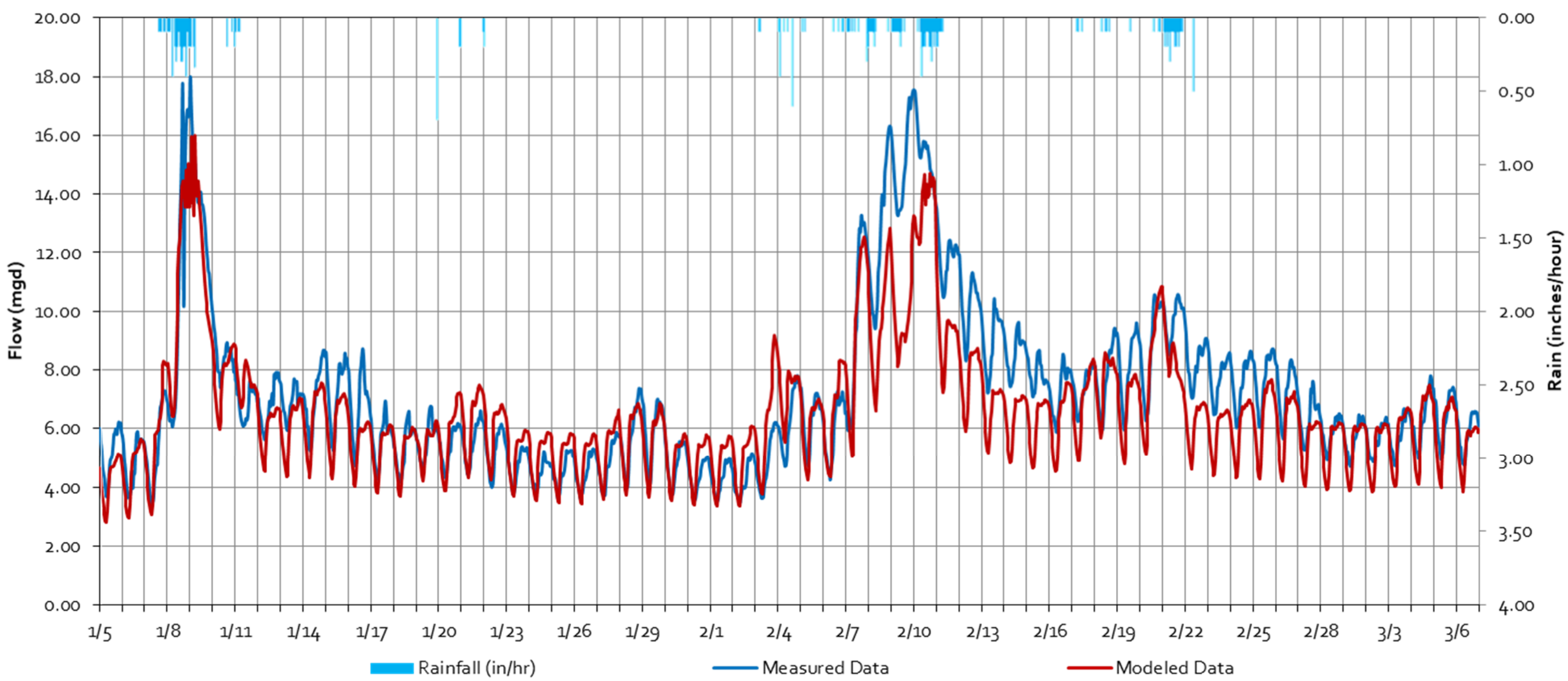
TSD flow meter verification (continued)



TSD flow meter verification (continued)



WRP wet weather flow calibration results



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Tahoe-Truckee Sanitation Agency
Master Sewer Plan

VOLUME 2:
COLLECTION SYSTEM MASTER PLAN
CHAPTER 5:
TRI CAPACITY EVALUATION

FINAL | February 2022

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Chapter 5

TRI CAPACITY EVALUATION

5.1 Introduction

The Tahoe-Truckee Sanitation Agency (T-TSA) provides wastewater treatment and collection for the North Lake Tahoe and Truckee region. Wastewater is conveyed to the Water Reclamation Plant (WRP) via the Truckee River Interceptor (TRI). The TRI flows south to north and begins in Tahoe City and follows the Truckee River and State Highway 89 to the Town of Truckee. T-TSA contracted Carollo Engineers, Inc. (Carollo) to assist in evaluation of the TRI using the calibrated hydraulic model. In addition, this chapter summarizes the evaluation criteria used to analyze the hydraulic model outputs.

5.2 Evaluation Criteria

This section presents the planning criteria and methodologies for the analysis used to evaluate the TRI and associated facilities, which are utilized to identify existing system deficiencies, and to size future improvements and expansions. The planning criteria address the collection system capacity, acceptable gravity sewer pipe slopes, and maximum allowable depth of flow, design velocities, and changes in pipe size. The TRI was evaluated against several flow conditions and evaluation parameters.

5.2.1 Gravity Sewers

Gravity sewer pipe capacities are dependent on many factors. The factors include roughness of the pipe, the chosen maximum allowable depth of flow downstream, and limiting velocity and slope. The following sections describe the factors that account for the determination of existing and future pipeline capacities in the T-TSA's collection system.

5.2.1.1 Manning's Coefficient (*n*)

The Manning's coefficient "*n*" is a friction coefficient that varies with respect to pipe material, size of pipe, depth of flow, smoothness of joints, root intrusion, and other factors. For sewer pipes, the Manning's coefficient typically ranges between 0.011 and 0.017, with 0.013 being a representative value used for system planning purposes. Due to unknown conditions of existing pipelines, a conservative Manning's "*n*" factor of 0.013 was initially used for the evaluation of all existing collection system pipelines. Pipe roughness values were adjusted during calibration. The evaluation of all proposed pipelines also used a Manning's "*n*" factor of 0.013.

5.2.1.2 Peak Flow Depth Criteria

The primary criterion used to identify pipeline capacity deficiencies or to size new sewer improvements is the peak flow depth criteria. The maximum flow depth criteria for existing sanitary sewers are established based on a number of factors, including the acceptable risk tolerance of the utility, local standards and codes, and other factors. Using a conservative flow depth criteria when evaluating existing sewers may lead to unnecessary replacement of existing pipelines. Conversely, lenient flow depth criteria could increase the risk of sanitary sewer overflows (SSOs). Ultimately, the maximum allowable flow depth criteria should be established to be as cost-effective as possible while at the same time reducing the risk of SSOs to the greatest extent possible. For the TRI, pipelines were flagged if the pipe surcharged within 2 feet of the manhole rim. The peak flow depth criteria was evaluated under high occupancy dry weather flow (DWF) plus design storm volumes for existing and future conditions.

System bottlenecks raise the hydraulic grade line of upstream sewers, leading to backwater conditions. The greater the capacity deficiency, the higher water levels will surcharge upstream of the bottleneck pipeline (or pipelines). The hydraulic model is used to determine "backwater" pipelines in order to specify which specific pipelines are the actual root causes of the capacity deficiency. Capital projects are proposed to provide greater flow capacity for the deficient sewers, which eliminates the backwater conditions that cause surcharging.

5.2.2 Design Storm for Sewer System Planning

As noted in Section 3.4 of Volume 2, Chapter 3 of this plan, the 10-year, 24-hour design storm was used for analyzing capacity of the TRI. Figure 5.1 shows the 10-year, 24-hour design storms.

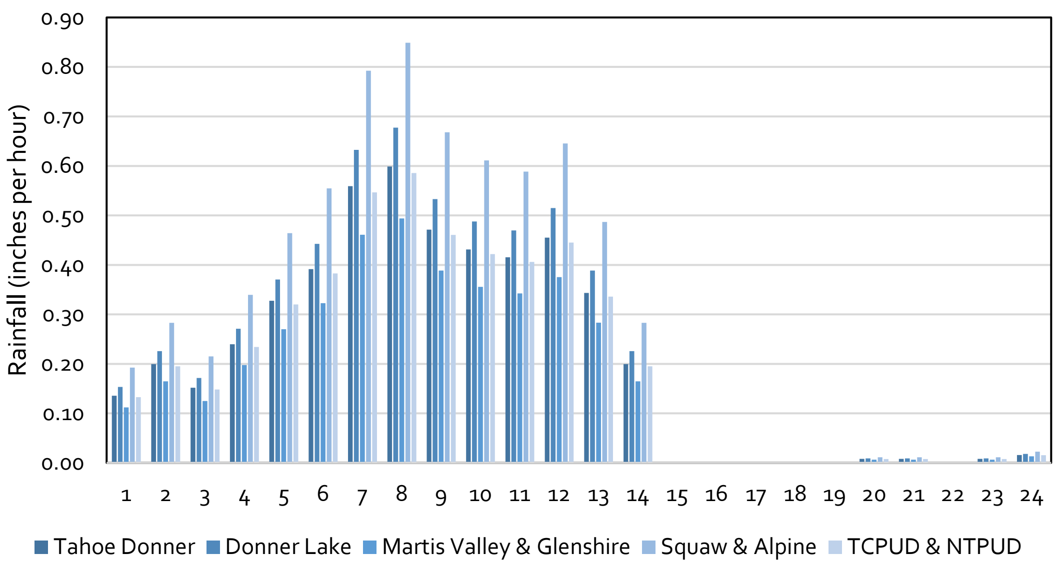

Figure 5.1 10-Year, 24-Hour Design Storms

5.3 TRI Capacity Evaluation System Analysis

Following the dry and wet weather flow calibration, which is summarized in detail in Volume 2, Chapter 4, a capacity analysis of the TRI was performed under the existing and future flow conditions described in Volume 2, Chapter 3. The capacity analysis entailed identifying areas in the TRI where flow restrictions occur or where pipe capacity is insufficient to convey peak wet weather flows PWWFs. Sewers that lack sufficient capacity to convey PWWFs create bottlenecks in the system that can potentially cause SSOs.

For the existing TRI, the PWWF was routed through the hydraulic model. In accordance with the established flow depth criteria for existing sewers, manholes where the maximum hydraulic grade line HGL is within 2 feet of the manhole rim were considered to be deficient.

Note that the pipelines that surcharge within 2 feet of the manhole rim are not necessarily deficient. In some cases, a surcharged condition within a given pipeline is due to backwater effects created by a downstream bottleneck (i.e., upstream surcharging is caused by downstream pipeline deficiencies). An illustration of backwater effects is shown in Figure 5.2. For this reason, the hydraulic model was used to identify the pipeline segments that are capacity deficient (i.e., not subject to backwater conditions).

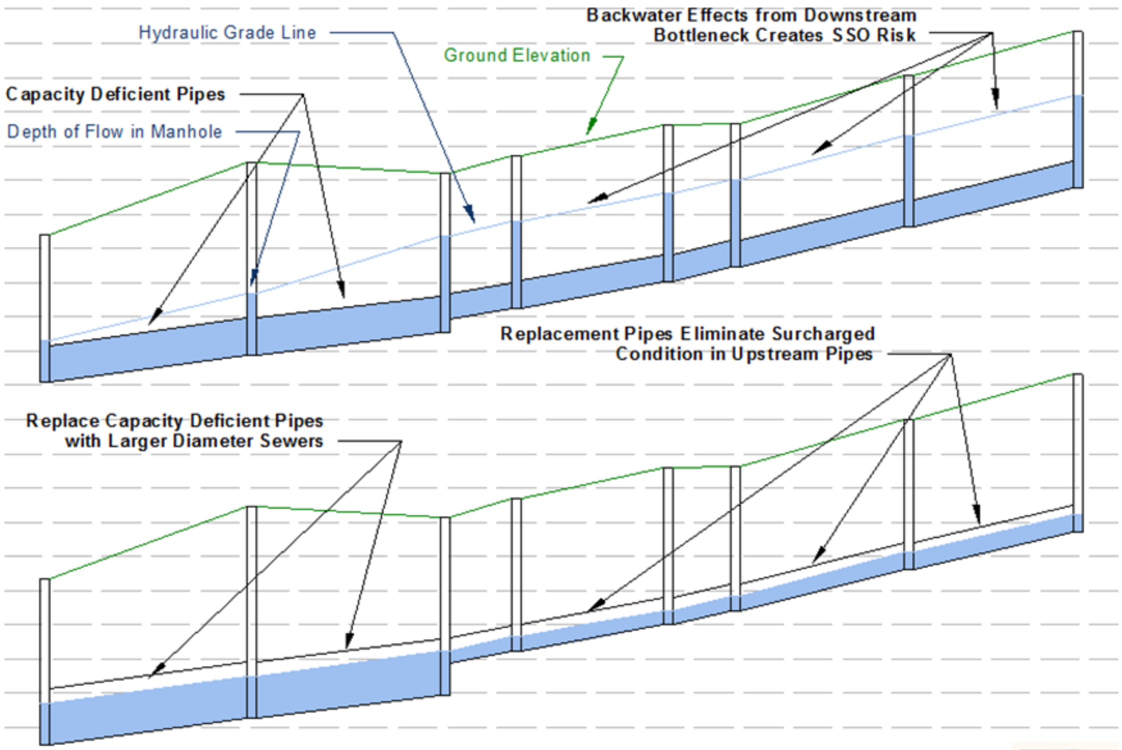

Figure 5.2 Sample Illustration of Backwater Effects in a Sewer

5.3.1 Existing TRI Evaluation

The TRI has sufficient capacity to convey current PWWFs without exceeding the established flow depth criterion.

Figure 5.3 shows the existing high occupancy DWF and PWWF hydrograph at the WRP for 2 days. As shown in Figure 5.3, the model simulated PWWF at the WRP is 21.9 million gallons per day (mgd). The TRI Remaining EDU Analysis TM provided in Appendix 5A provides additional analysis of the remaining capacity in each major segment of the TRI.

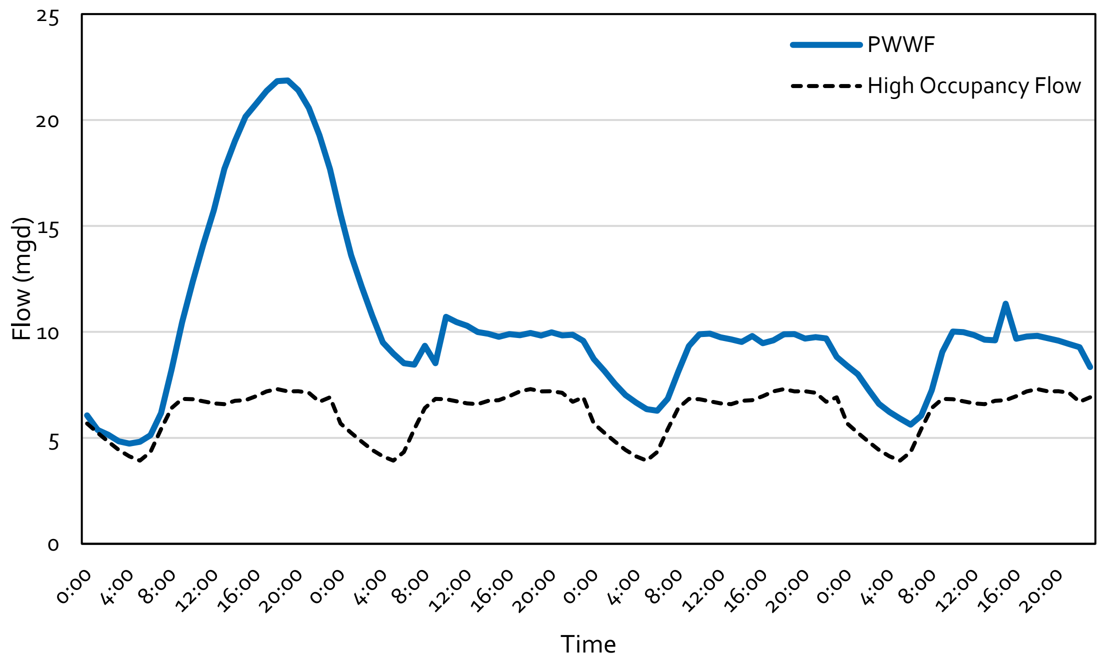

Figure 5.3 Existing PWWF Hydrograph at the WRP

5.3.2 Future (2045) TRI Evaluation

Following the completion of the existing system analysis, improvement projects and alternatives were identified in order to mitigate existing system pipeline capacity deficiencies. The recommended improvement projects are discussed in greater detail in Volume 2, Chapter 6. The analysis of the future system was performed in a manner similar to the existing system analysis. The future system evaluation verifies that the existing system improvements were appropriately sized to convey future PWWFs, and also identifies the locations of existing sewers that are inadequately sized to convey future PWWFs.

By 2045, the PWWF is projected to increase to 30.0 mgd, as shown in Figure 5.4. Similar to the existing system analysis, the TRI generally has sufficient capacity to convey future PWWFs without exceeding the established flow depth criterion, with a couple of exceptions. The pipelines that were flagged as capacity deficient under future PWWF conditions are shown on Figure 5.5 in thick red lines. Replacing a capacity limited (bottleneck) sewer will allow for higher peak flows to be carried to downstream sewers. The following stretches of gravity main were flagged as being deficient.

- *Gravity Main between MH 57 and MH 62:* This project includes the replacement of approximately 4,290 feet of 24-inch and 27-inch diameter pipeline. The flow levels of the gravity sewer cause upstream manholes to surcharge within 2 feet of the manhole rim under future PWWF conditions.
- *Gravity Main between MH 71 and MH 72:* This project includes the replacement of approximately 990 feet of 24-inch diameter pipeline. The flow levels of the gravity sewer causes upstream manholes to surcharge within 2 feet of the manhole rim under future PWWF conditions.

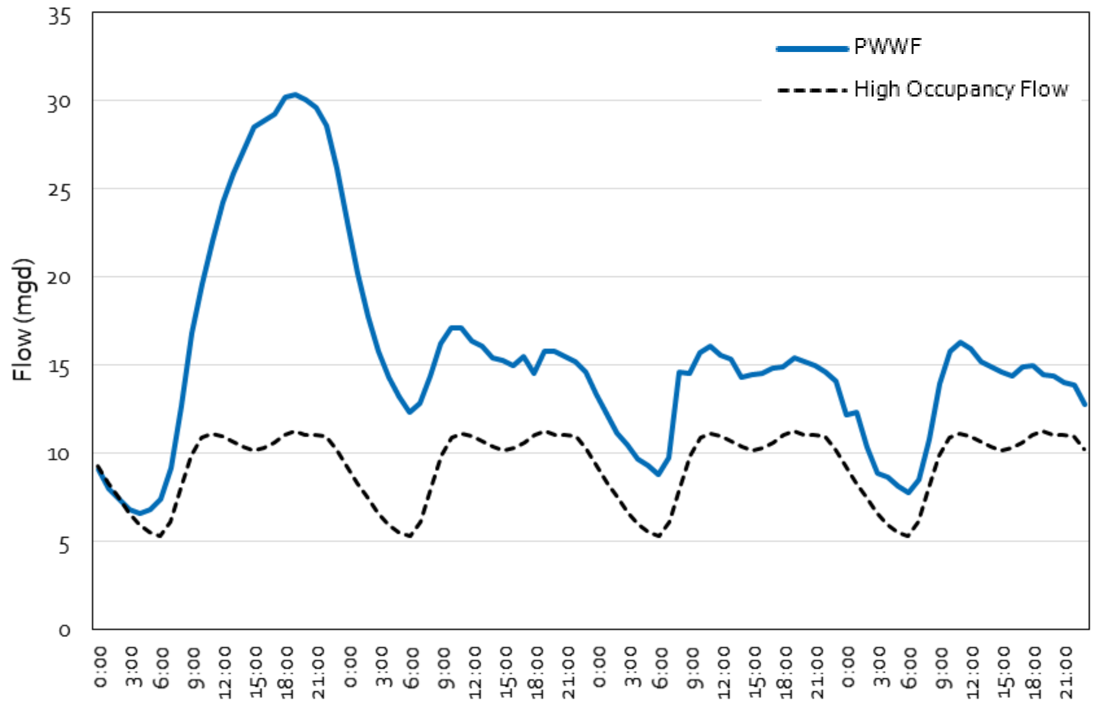

Figure 5.4 Future PWWF Hydrograph at the WRP

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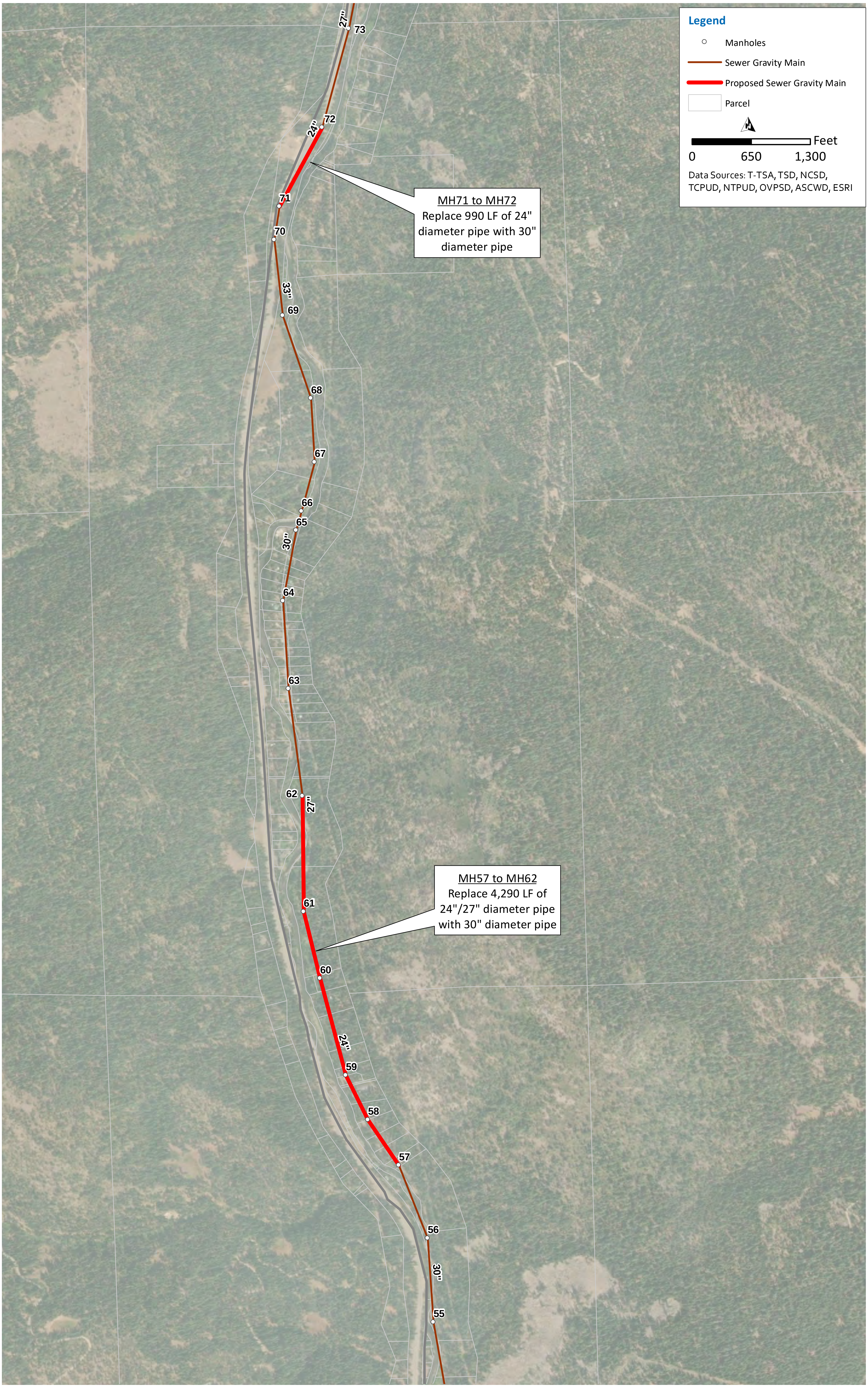

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Figure 5.5 Future TRI Capacity Deficiencies

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5.4 Conclusions

Overall, the existing TRI has sufficient capacity to convey the existing and projected PWWF conditions. However, for future PWWF conditions, there are two stretches of the TRI that do not have sufficient capacity. Improvement projects and alternatives were identified in order to mitigate future system pipeline capacity deficiencies. The recommended improvement projects to mitigate the system deficiencies from Section 5.3.2 are discussed in greater detail in Volume 2, Chapter 6, TRI Recommendations.

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Appendix 5A

TRUCKEE RIVER INTERCEPTOR REMAINING EDU ANALYSIS

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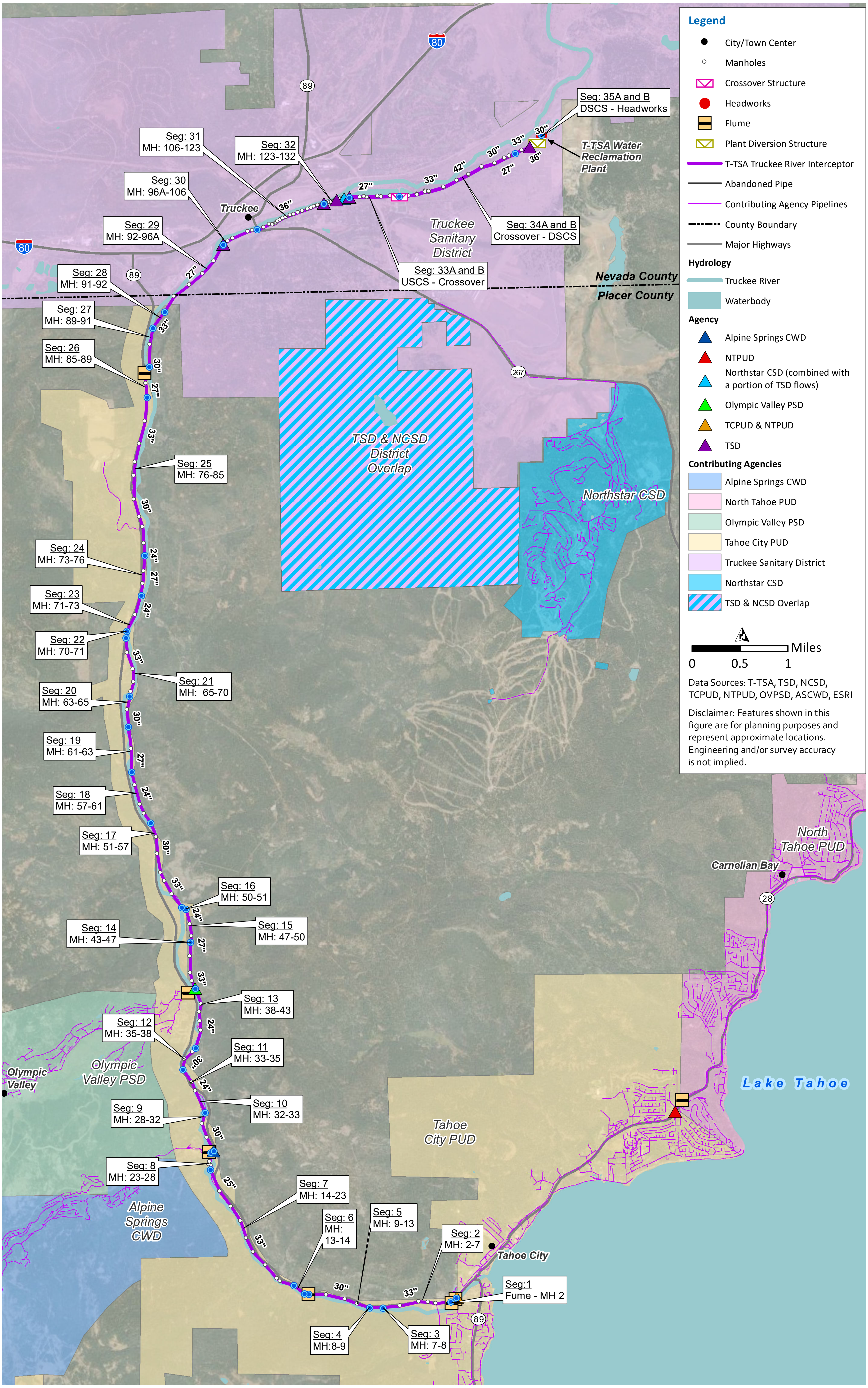

Figure A TRI Available Capacity Analysis Segments

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Estimated Remaining Available Capacity in the TRI, by Segment

Segment Number	Upstream Manhole ID	Downstream Manhole ID	Est. Remaining Available Capacity under Existing PWWFs (mgd)	Est. Remaining Available Capacity under Existing PWWFs (EDUs)[1]	Est. Remaining Available Capacity under Existing PWWFs and Improvement Projects C-1 and C-2 (mgd)	Est. Remaining Available Capacity under Existing PWWFs and Improvement Projects C-1 and C-2 (EDUs)[1]
1	WS Flume	2	1.40	2,333	2.80	4,667
2	2	7	1.40	2,333	2.80	4,667
3	7	8	1.38	2,300	2.83	4,722
4	8	9	1.38	2,297	2.84	4,733
5	9	13	1.39	2,308	2.84	4,740
6	13	14	1.39	2,308	2.87	4,777
7	14	23	1.37	2,290	2.90	4,840
8	23	28	1.37	2,290	2.78	4,640
9	28	32	1.38	2,292	2.78	4,640
10	32	33	1.37	2,283	2.80	4,667
11	33	35	1.38	2,300	2.77	4,612
12	35	38	1.37	2,283	2.77	4,610
13	38	43	1.37	2,285	2.77	4,610
14	43	47	1.38	2,307	2.76	4,603
15	47	50	1.38	2,307	2.76	4,597
16	50	51	1.39	2,308	2.76	4,597
17	51	57	1.39	2,312	2.76	4,597
18	57	61	1.39	2,312	2.76	4,597
19	61	63	1.51	2,517	2.76	4,597
20	63	65	1.51	2,517	2.76	4,597
21	65	70	1.51	2,517	2.76	4,592
22	70	71	1.51	2,517	2.75	4,590
23	71	73	1.51	2,517	2.75	4,590
24	73	76	2.75	4,585	2.76	4,592
25	76	85	2.75	4,585	2.76	4,595
26	85	89	5.20	8,667	5.20	8,667
27	89	91	5.14	8,563	5.20	8,660
28	91	92	5.27	8,783	5.28	8,792
29	92	96A	5.50	9,165	5.55	9,253
30[2]	96A	106	>10	>16,667	>10	>16,667
31[2]	106	123	>10	>16,667	>10	>16,667
32[2]	123	132	>10	>16,667	>10	>16,667
33A/33B[2]	USCS	Crossover Structure	>10	>16,667	>10	>16,667
34A/34B[2]	Crossover Structure	DSCS	>10	>16,667	>10	>16,667
35A/35/B[2]	DSCS	Headworks	>10	>16,667	>10	>16,667

Notes:

(1) Remaining Available Equivalent Dwelling Units = Remaining Available Capacity/((200 gpd/EDU)*3). Assumed a peaking factor of 3.

(2) The remaining available capacity for segments30-35A/35B varies depending on which diversion structures are in operation and which diversion ponds are operated. Carollo found that the remaining available capacity in these reaches is estimated to be at least 10 mgd.

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Tahoe-Truckee Sanitation Agency
Master Sewer Plan

VOLUME 2:
COLLECTION SYSTEM MASTER PLAN
CHAPTER 6:
TRI RECOMMENDATIONS

FINAL | February 2022

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Chapter 6
TRI RECOMMENDATIONS

6.1 Introduction

The Tahoe-Truckee Sanitation Agency (T-TSA/Agency) provides wastewater treatment and collection for the North Lake Tahoe and Truckee region. Wastewater is conveyed to the Water Reclamation Plant (WRP) via the Truckee River Interceptor (TRI). T-TSA contracted Carollo Engineers, Inc. (Carollo) to make recommendations based on the TRI capacity evaluation and condition assessment as discussed in Volume 2, Chapter 5 - TRI Capacity Evaluation and in Volume 2, Chapter 2 - Condition Assessment and Asset Management, respectively. These recommendations also reflect discussions with T-TSA regarding the TRI.

6.2 Project Phasing

As discussed in Volume 2, Chapter 2 - Condition Assessment and Asset Management, the TRI projects were broken into five groups. These groups were used to help prioritize the renewal projects based on the overall condition of the TRI pipeline segments. Similarly, all TRI related projects were grouped into five phases as shown below:

- Phase 1: Years 2022 through 2026.
- Phase 2: Years 2027 through 2031.
- Phase 3: Years 2032 through 2036.
- Phase 4: Years 2037 through 2041.
- Phase 5: Years 2042 through 2046.

The project phasing will be used in the capital improvement plan (CIP) of this Master Plan. Critical projects were phased in the earlier phases (years) of the 25-year CIP. Less critical projects were phased into later phases of the 25-year CIP.

6.3 TRI Improvements

The improvements recommended to address deficiencies in the TRI are provided in Figures 6.1 and 6.2. These improvements are also itemized by project in Table 6.1 with a cross-referenced numbering system. The columns used in Table 6.1 refer to the following:

- *Project ID:* Assigned number that corresponds to the Proposed Improvements Table. This is an alphanumeric number that starts with one letter indicating the type of improvement (C = Capacity; RR = Rehabilitation and Replacement; O = Other) and continues with a number.
- *Project Name:* Name of the project.
- *Type of Improvement:* Describes the type of improvement (modification, replacement, or lining) for an existing facility.
- *Description:* Summarizes the proposed improvement.
- *Reason:* Summarizes why the improvement is needed.

- *Proposed Quantity:* Estimated length or number of units for the proposed improvement, if applicable. It should be noted that the length estimates do not account for re-routing the alignment to avoid unknown conditions.
- *Existing Size:* This is the size of the existing pipeline/facility. It represents the diameter of the existing pipeline(s) (in inches).
- *Proposed Size:* This is the size of the proposed improvement. It represents the diameter of the existing pipeline(s) (in inches).
- *Proposed Phase:* This is which phase of the 25-year CIP the project is proposed to be implemented in.

The following sections describe the recommended improvements in greater detail.

6.3.1 TRI Capacity Improvements

Figure 6.1 illustrates the recommended capacity improvements to mitigate the collection system deficiencies. This section provides a detailed description of each recommended wastewater collection system improvement project. The capacity recommendations were developed to mitigate capacity deficiencies identified in Volume 2, Chapter 5 - TRI Capacity Evaluation. The following capacity improvements are recommended for the TRI:

- *Gravity Main between manhole (MH) 57 and MH 62 (Project C-1):* This project includes the replacement of approximately 4,290 feet of 24-inch and 27-inch diameter pipeline between MH 57 and MH 62. The flow levels of the gravity sewer cause upstream manholes to surcharge within 2 feet of the manhole rim under future peak wet weather flow (PWWF) conditions. To mitigate the risk of sanitary sewer overflows (SSO) occurring during PWWF conditions, it is recommended that the existing pipeline be replaced with a 30-inch diameter pipeline. The phasing of this project will depend on the rate of growth in flows in the TRI. For planning purposes, it is assumed that this project will be constructed in Phase 3 (2032-2036).
- *Gravity Main between MH 71 and MH 72 (Project C-2):* This project includes the replacement of approximately 990 feet of 24-inch diameter pipeline between MH 71 and MH 72. The flow levels of the gravity sewer cause upstream manholes to surcharge within 2 feet of the manhole rim under future PWWF conditions. To mitigate the risk of SSOs occurring during PWWF conditions, it is recommended that the existing pipeline be replaced with a 30-inch diameter pipeline. The phasing of this project will depend on the rate of growth in flows in the TRI. For planning purposes, it is assumed that this project will occur in Phase 4 (2037-2041).

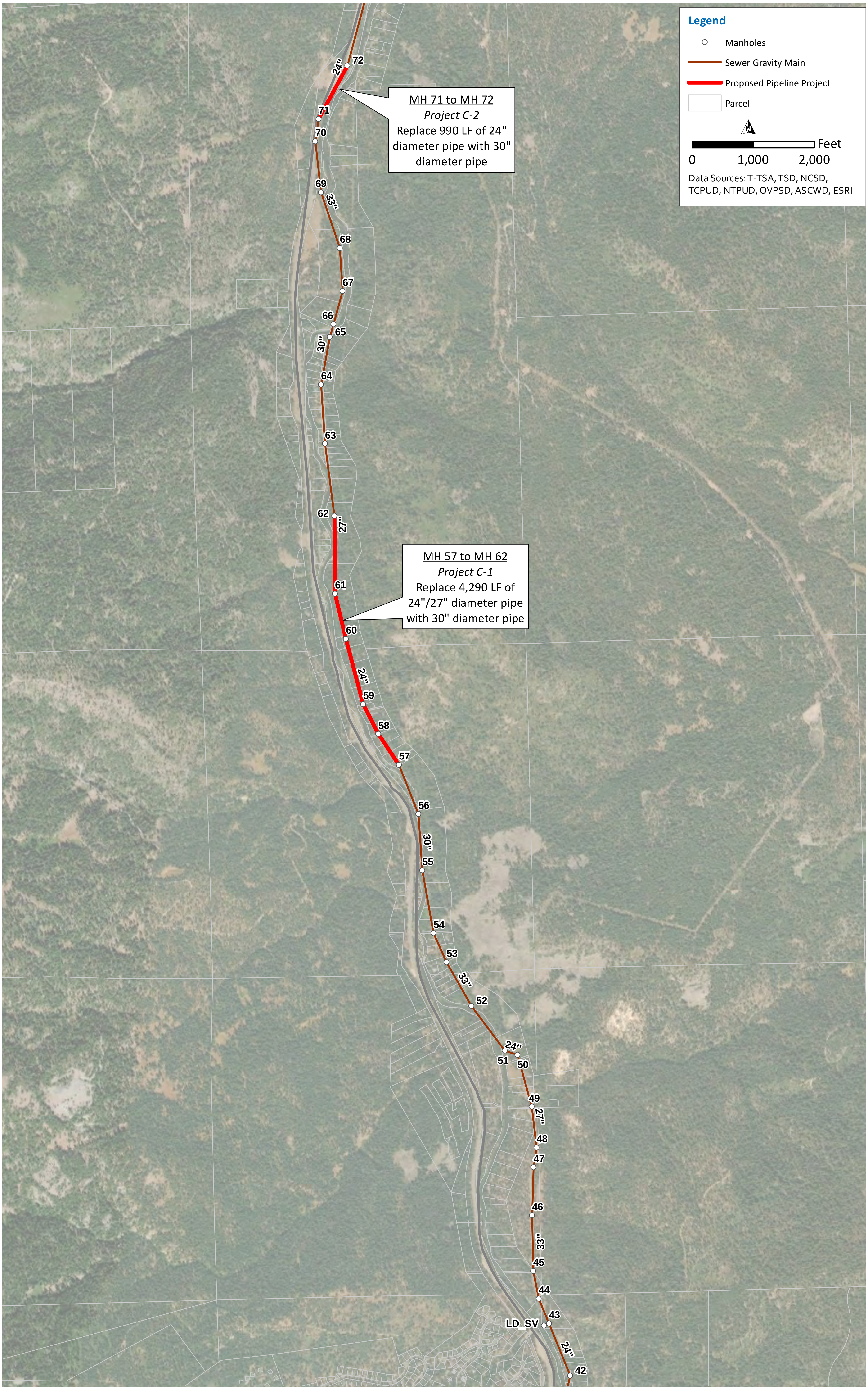

Figure 6.1 TRI Capacity Improvements

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6.3.2 TRI Condition Assessment Improvements

Figure 6.2 illustrates the recommended condition assessment improvements. This section only provides a detailed description for Phase 1 and Phase 2 condition assessment projects. It should be noted that the Phase 2 through Phase 5 projects should be updated as more information is learned regarding the rate of deterioration as monitored through T-TSA's recent implementation of improved TRI Asset Management Program processes, which includes monitoring of locations where reinforcement is visible. The proposed Visible Reinforcement Study will also inform future Phase 2 through Phase 5 projects. The condition assessment recommendations were developed to mitigate segments of the TRI that are in poor condition as identified in Volume 2, Chapter 2 - Condition Assessment and Asset Management. The following condition related improvements are recommended for the TRI:

- *River Crossing, Gravity Main between MH 33 and MH 35 (Project RR-1):* This project includes lining approximately 1,380 feet of 24-inch diameter pipeline between MH 33 and MH 35. T-TSA is concerned about TRI segments crossing under the Truckee River and plans to renew these segments. Thus it is recommended that this project occur in Phase 1 (2022-2026), specifically during the years 2022-2024.
- *River Crossing, Gravity Main between MH 65 and MH 66 (Project RR-2):* This project includes lining approximately 220 feet of 30-inch diameter pipeline between MH 65 and MH 66. T-TSA is concerned about TRI segments crossing under the Truckee River and plans to renew these segments. Thus, it is recommended that this project begin in the later part of Phase 1 (2022-2026) and be completed in early Phase 2 (2027-2031), specifically during the years 2025-2027. Additionally, given the length of this segment, it is recommended that this project be grouped with Project RR-3.
- *River Crossing, Gravity Main between MH 88 and MH 89 (Project RR-3):* This project includes lining approximately 220 feet of 30-inch diameter pipeline between MH 88 and MH 89. T-TSA is concerned about TRI segments crossing under the Truckee River and plans to renew these segments. Thus, it is recommended that this project begin in the later part of Phase 1 (2022-2026) and be completed in early Phase 2 (2027-2031), specifically during the years 2025-2027. Additionally, given the length of this segment, it is recommended that this project be grouped with Project RR-2.
- *TRI Renewal Program (Project RR-4):* The TRI Renewal Program addresses sewer infrastructure that is susceptible to failure through R&R projects. The actual R&R projects and phasing should be based on current inspections as documented and evaluated in T-TSA's new TRI Asset Management Program. Results of the structural integrity analysis performed in the proposed Visible Reinforcement Study will also be used to determine actual R&R projects and phasing. The TRI Renewal Program consists of an annual budget to ensure T-TSA has funding to complete R&R projects.

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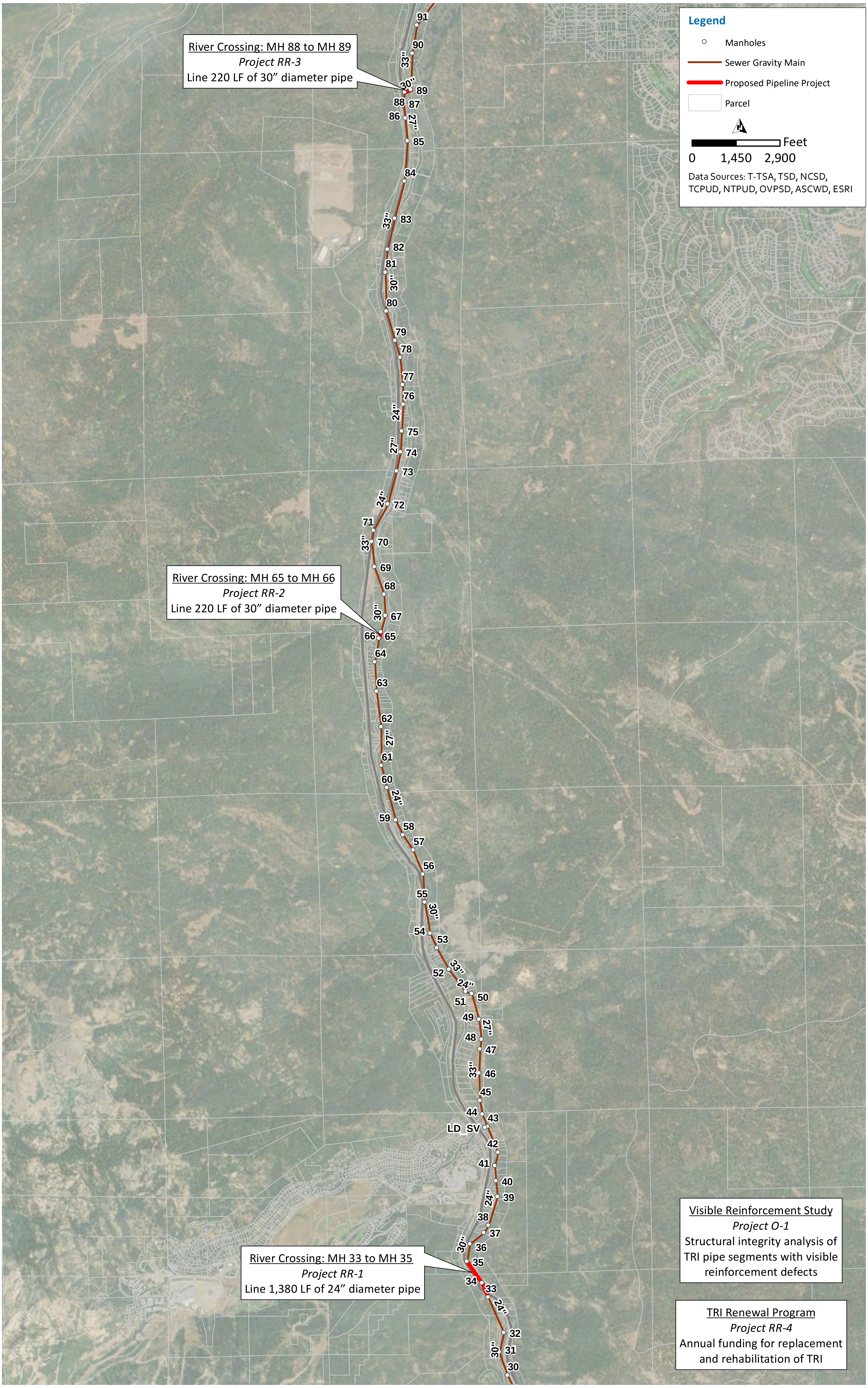

Figure 6.2 TRI Condition Assessment Improvements

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6.3.3 Other Recommendations

This section summarizes other recommendations related to the TRI. However, since T-TSA is now implementing the TRI Asset Management Program, in part due to Master Plan discussions and meetings, it is not included in the CIP. Figure 6.2 shows the Visible Reinforcement Study, which is included in the CIP.

- *TRI Asset Management Program:* The program is designed to manage data and track TRI degradation. In addition, the program will help T-TSA make decisions related to the TRI Renewal Program using a standardized method. As of fall 2020, the Agency is implementing its TRI Asset Management Program using the AIMS program and making plans to integrate the TRI Asset Management program utilizing the Lucity, Inc. software platform. Currently the Agency is implementing Lucity for treatment plant and TRI assets.
- *Visible Reinforcement Study (Project O-1):* It is recommended that a Visible Reinforcement Study be conducted to understand the structural integrity of TRI segments with visible reinforcement defects. During the July 9, 2020 meeting, T-TSA staff noted that they plan to continue to carefully inspect these pipe segments with visible reinforcement defects when the segments are scheduled to be digitally scanned, in order to better monitor their condition and degradation. A Visible Reinforcement Study, including a structural integrity analysis, is recommended to augment T-TSA's ongoing monitoring efforts. The TRI Asset Management Program will utilize information from ongoing digital scans as well as the Visible Reinforcement Study to inform the Agency's decisions regarding the TRI Renewal Program, including TRI segments with visible reinforcement defects. It is recommended that this study occur in Phase 1 (2022-2026), with a follow up study in Phase 2 (2027-2031).

6.4 Conclusion

Based on the TRI Capacity Evaluation, approximately 1 mile of the TRI is projected to require capacity upgrades within the planning period of this Master Plan. In addition, based on the TRI Condition Assessment, approximately 0.4 miles of the TRI are specifically recommended to be rehabilitated within the planning period of this Master Plan, due to the consequence of failure as a result of these segments being river crossings. It is also recommended that the Agency set aside funding for additional rehabilitation projects for the TRI under the TRI Renewal Program, although the exact length of affected sewer main is unknown at this time. This uncertainty is due to the fact that specific R&R projects have not been identified, owing to their dependence on data from the forthcoming Visible Reinforcement Study and TRI Asset Management Program.

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Table 6.1 Proposed Improvements

Project ID	Project Name	Type of Improvement	Description	Reason	Proposed Quantity	Existing Size	Proposed Size	Proposed Phase
Capacity Improvements								
C-1	Gravity Main between MH 57 and MH 62	Replace	Replace and upsize gravity sewer main to mitigate risk of SSOs	Undersized for future PWWFs	4,290 LF	24-inch & 27-inch	30-inch	Phase 3
C-2	Gravity Main between MH 71 and MH 72	Replace	Replace and upsize gravity sewer main to mitigate risk of SSOs	Undersized for future PWWFs	990 LF	24-inch	30-inch	Phase 4
Condition Assessment Improvements								
RR-1	River Crossing, Gravity Main between MH 33 and MH 35	Line	Line existing gravity sewer main under Truckee River	High consequences if sewer pipeline fails within the banks of the Truckee River	1,380 LF	24-inch	24-inch	Phase 1
RR-2	River Crossing, Gravity Main between MH 65 and MH 66	Line	Line existing gravity sewer main under Truckee River	High consequences if sewer pipeline fails within the banks of the Truckee River	220 LF	30-inch	30-inch	Phase 1-2
RR-3	River Crossing, Gravity Main between MH 88 and MH 89	Line	Line existing gravity sewer main under Truckee River	High consequences if sewer pipeline fails within the banks of the Truckee River	220 LF	30-inch	30-inch	Phase 1-2
RR-4	TRI Renewal Program	Line/Replace	Address aging and deteriorating gravity sewer main through periodical R&R projects. Actual R&R projects and phasing to be determined, based on updated inspections.	Increases estimated service life	Varies	Varies	Varies	Phase 2 through 5
Other Improvements								
O-1	Visible Reinforcement Study	n/a	Perform structural integrity analysis of TRI pipe segments with visible reinforcement defects.	Better understand the structural integrity of TRI segments with visible reinforcement defects. Use information to determine R&R projects in TRI Renewal Program.	n/a	n/a	n/a	Phase 1 and 2

Notes:
(1) Abbreviations: LF = linear feet.

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Tahoe-Truckee Sanitation Agency
Master Sewer Plan

VOLUME 2:
COLLECTION SYSTEM MASTER PLAN
CHAPTER 7:
CAPITAL IMPROVEMENT PLAN

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Chapter 7

CAPITAL IMPROVEMENT PLAN

7.1 Introduction

This chapter presents the Tahoe-Truckee Sanitation Agency (T-TSA/Agency) capital improvement program (CIP) for the Truckee River Interceptor (TRI). This chapter includes a summary of the capital costs and a basic assessment of the possible financial impacts on T-TSA. This chapter is organized to assist the T-TSA in making financial decisions. The CIP is based on the TRI Recommendations as described in Volume 2, Chapter 6 - TRI Recommendations. It should be noted that although this CIP covers the entire 25-year planning period, it is highly recommended that the CIP be updated every 5 to 10 years to ensure that it remains current and relevant to the Agency.

7.2 Capital Improvement Projects

The capacity upgrades and other system capital improvements set the foundation of the T-TSA's TRI CIP. The cost estimates presented in this study are opinions developed from bid tabulations, cost curves, information obtained from previous studies, and Carollo Engineers, Inc. (Carollo) experience on other projects. The costs are based on current (November 2021) dollars (Engineering News Record (ENR) value of 14,421) and do not include any escalation.

7.3 Cost Estimating Accuracy

The cost estimates presented in the CIP have been prepared for general master planning purposes and for guidance in project evaluation and implementation. All project costs shown in this CIP are in November 2021 dollars; future costs will need to be adjusted for inflation. Final costs of a project will depend on actual labor and materials costs, competitive market conditions, final project scope, implementation schedule, and other variable factors such as preliminary alignment generation, investigation of alternative routings, and detailed utility and topography surveys.

The Association for the Advancement of Cost Engineering (AACE) defines an Order of Magnitude Estimate, deemed appropriate for master plan studies as an approximate estimate made without detailed engineering data. It is normally expected that an estimate of this type would be accurate within plus 50 percent to minus 30 percent. This section presents the assumptions used in developing order of magnitude cost estimates for recommended facilities.

7.4 Construction Unit Costs

The construction costs are representative of sewer collection system facilities under normal construction conditions and schedules. Costs have been estimated for public works construction.

All gravity sewer main replacement unit costs presented in this section include pipeline costs, excavation, and other appurtenances (e.g., manholes (MH), etc.). Given the size, location, and layout of the TRI, bypass pumping is assumed to be needed for all TRI pipeline projects. According to T-TSA, bypass pumping is a large cost for any project. As such, the gravity sewer unit costs also include bypass pumping. The unit costs are for "typical" field conditions with construction in stable soil at a depth ranging between 10 feet to 15 feet. For some projects, site conditions were unknown, such as in the case of river crossings. Therefore, for river crossing projects, a higher unit cost was used to account for this special condition.

Sewer pipeline improvements range in size from 18 inches to 42 inches in diameter. Unit costs for the construction of pipelines and associated appurtenances are shown in Table 7.1. These costs are based off similar projects completed by Carollo and have also been compared with recent T-TSA TRI project costs. The construction cost estimates are based upon these unit costs.

Table 7.1 Gravity Sewer Unit Costs

Diameter (inches)	Replacement Unit Cost ($/LF)	Line Unit Cost ($/LF)	River Crossing Unit Cost(1) ($/LF)
18	$440	$430	$620
24	$620	$580	$830
27	$690	$650	$930
30	$760	$720	$1,030
33	$860	$790	$1,130
36	$960	$860	$1,230
42	$1,160	$1,000	$1,430

Notes:
(1) River Crossing Unit costs are based on pipe lining (rehabilitation) methods.
Abbreviations: LF = linear feet.

7.5 Project Costs and Contingencies

Project cost estimates are calculated based on elements such as the project location, size, length, and other factors. Allowances for project contingencies consistent with an "Order of Magnitude" estimate are also included in the project costs prepared as part of this study, as outlined in this section.

7.5.1 Total Direct Cost

The Total Direct Cost is the unit cost times the quantity, and includes the cost of materials, labor, and equipment for a given element of work.

7.5.2 Baseline Construction Cost

The Baseline Construction Cost is the Total Direct Cost plus an estimating contingency that reflects the level of detail and development of the estimate. Contingency costs must be reviewed on a case-by-case basis because they can vary considerably with each project. Consequently, it is appropriate to allow for uncertainties associated with the preliminary layout of a project. Factors such as unexpected construction conditions, the need for unforeseen mechanical items, and variations in final quantities are a few of the items that can increase project costs for which it is wise to make allowances in the preliminary estimates. Since knowledge about site-specific conditions of each proposed project is limited at the master planning stage, a 30 percent contingency was applied to the Total Direct Cost to account for unknown site conditions such as unforeseen conditions, environmental mitigations, and other factors, which is typical for master planning projects.

7.5.3 Total Construction Cost

The Total Construction Cost consists of a sum of the Baseline Construction Cost and Indirect Costs. Indirect Costs include all costs that are not readily seen in the end product, but are costs included in the contractors' bids. Examples of Indirect Costs include overhead, profit, risk, taxes, and inflation.

For these planning level estimates, a 25 percent contingency was used to account for the general contractor's general conditions, overhead, and profit. In addition, the local 8.25 percent sales tax was applied to 50 percent of the Baseline Construction Cost to cover sales tax on materials and equipment.

7.5.4 Capital Improvement Cost

Other project construction contingency costs include costs associated with project engineering, construction phase professional services, and project administration. Engineering services associated with new facilities include preliminary investigation and reports, right-of-way (ROW) acquisition, foundation explorations, preparation of drawings and specifications during construction, surveying and staking, sampling and testing of materials, and start-up services. Construction phase professional services cover items such as construction management, engineering services during construction, materials testing, and inspection during construction. Finally, there are project administration costs, which cover items such as legal fees, environmental/California Environmental Quality Act (CEQA) compliance requirements, permitting compliance, financing expenses, administrative costs, and interest during construction. The cost of these items can vary, but for the purpose of this study, it is assumed that these costs will equal approximately 25 percent of the Total Construction Cost. No land acquisition costs were assumed as part of the TRI CIP, as the alignment of the TRI is not proposed to change.

As shown in the following example calculation of the Capital Improvement Cost, the total cost of all project construction contingencies (construction, engineering services, construction management, and project administration) is 210 percent of the Total Direct Cost. Calculation of the 210 percent is the overall mark-up on the Total Direct Cost to arrive at the Capital Improvement Cost. It is not an additional contingency.

Example:

Total Direct Cost	**$1,000,000**
Construction Contingency (30%)	$300,000
Baseline Construction Cost	**$1,300,000**
Contractor Cost (25%)	$325,000
50% Sales Tax (8.25%)	$54,000
Total Construction Cost	**$1,679,000**
Engineering (10%)	$168,000
Construction Management (5%)	$84,000
Legal & Permitting (10%)	$168,000
Capital Improvement Cost	**$2,099,000**

7.6 CIP

A summary of the capital project costs for the TRI is presented in Table 7.2. The table identifies the projects, provides a brief description of each project, identifies facility sizes (e.g., pipe diameter and length), provides capital improvement costs, and shows the probable phase in which the projects would be implemented. The columns used in this table refer to the following:

- *Project ID:* Assigned number that corresponds to the 25-Year TRI CIP Table. This is an alphanumeric number that starts with one letter indicating the type of improvement (C = Capacity, RR = Rehabilitation and Replacement, O = Other) and continues with a number.
- *Project Name:* Provides a descriptive name for each project.
- *Type of Improvement:* Describes the type of improvement (modification, replacement, or lining) for an existing facility.
- *Proposed Quantity:* Estimated length or number of units for the proposed improvement, if applicable. It should be noted that the length estimates do not account for re-routing the alignment to avoid unknown conditions.
- *Existing Size:* This is the size of the existing pipeline/facility. It represents the diameter of the existing pipeline(s) (in inches).
- *Proposed Size:* This is the size of the proposed improvement. It represents the diameter of the existing pipeline(s) (in inches).
- *Direct Unit Cost:* This is the estimated direct cost per unit of pipeline.
- *Total Project Cost:* This is the estimated total CIP project cost.
- *Phase:* This is which phase of the 25-year CIP the project is proposed to be implemented in. Projects proposed to be implemented in Phase 1 (2022-26) are shown in more detail, specifically showing which year is proposed for implementation.

The implementation timeframe was based on the priority of each project to correct existing deficiencies or to address future capacity needs. Implementation timeframes were also based on feedback from T-TSA staff, who noted that TRI projects have historically taken 3 years to implement, from permitting and design, to completion.

Table 7.2 25-Year TRI CIP

Project ID	Project Name	Type of Improvement	Proposed Quantity (LF)	Existing Size (inches)	Proposed Size (inches)	Direct Unit Cost ($/LF)	Total Project Cost	Phase 1					Phase 2 2027-31	Phase 3 2032-36	Phase 4 2037-41	Phase 5 2042-46
								2022	2023	2024	2025	2026				
Capacity Improvements																
C-1	Gravity Main between MH 57 and MH 62	Replace	4,290	24/27	30	$760	$7,180,000	$0	$0	$0	$0	$0	$0	$7,180,000	$0	$0
C-2	Gravity Main between MH 71 and MH 72	Replace	990	24	30	$760	$1,660,000	$0	$0	$0	$0	$0	$0	$0	$1,660,000	$0
Condition Assessment Improvements																
RR-1	River Crossing, Gravity Main between MH 33 and MH 35	Line	1,380	24	24	$830	$2,520,000	$252,000	$454,000	$1,814,000	$0	$0	$0	$0	$0	$0
RR-2	River Crossing, Gravity Main between MH 65 and MH 66	Line	220	30	30	$1,030	$500,000	$0	$0	$0	$50,000	$90,000	$360,000	$0	$0	$0
RR-3	River Crossing, Gravity Main between MH 88 and MH 89	Line	220	30	30	$1,030	$500,000	$0	$0	$0	$50,000	$90,000	$360,000	$0	$0	$0
RR-4	TRI Renewal Program	Line/Replace	Varies	Varies	Varies	Varies	$16,350,000	$0	$0	$0	$0	$0	$4,087,500	$4,087,500	$4,087,500	$4,087,500
Other Improvements																
O-1	Visible Reinforcement Study	--	--	--	--	--	$170,000	$105,000	$0	$0	$0	$0	$65,000	$0	$0	$0
Total CIP Cost						--	$28,875,000	$357,000	$454,000	$1,814,000	$100,000	$180,000	$4,872,500	$11,267,500	$5,747,500	$4,087,500
Estimated CIP Annual Cost						--	$1,155,000	$357,000	$454,000	$1,814,000	$100,000	$180,000	$974,500	$2,254,000	$1,150,000	$818,000

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7.7 25-Year CIP

The proposed capital improvements are prioritized based on their urgency to mitigate existing deficiencies and other factors. The capital improvements were phased into one of the following phases:

- Phase 1: Years 2022 through 2026. This phase includes projects that are targeted as the highest priority improvements.
- Phase 2: Years 2027 through 2031. This phase generally includes medium high priority improvements.
- Phase 3: Years 2032 through 2036. This phase generally includes medium priority improvements.
- Phase 4: Years 2037 through 2041. This phase generally includes medium low priority improvements.
- Phase 5: Years 2042 through 2046. This phase includes lower priority improvements that are based on industry anticipated life assumptions for infrastructure.

Each project is itemized by phase in Table 7.2. Per conversations with the Agency, a 3-year timeframe for TRI pipeline projects has been included in the CIP, to account for permitting and access complexities. It should be noted that the CIP phasing included in the 25-year CIP, and summarized in Table 7.2, is based on the project prioritization factors described in Volume 2, Chapter 6 - TRI Recommendations, and represents the preferred implementation schedule for the proposed improvements. Funding availability may limit the T-TSA's ability to implement the proposed projects according to the implementation schedule included in Table 7.2.

The 25-year TRI CIP is summarized by phase and project type in Table 7.3. As shown in Table 7.3 and graphically in Figure 7.2, out of the total $28.9 million in capital projects, $2.9 million are targeted for implementation in Phase 1, and an additional $21.9 million are targeted for Phases 2 through 4. The remaining $4.1 million of capital improvements has been included in Phase 5.

Table 7.3 and Figure 7.1 show the distribution of capital costs by project type. As shown in Figure 7.1, gravity main condition assessment projects account for the largest portion of the capital improvement project costs at 69 percent. Capacity projects account for roughly 31 percent of the total TRI CIP cost.

Table 7.3 25-Year TRI CIP Summary[(1)]

Improvement Type	Total CIP Cost	Phase 1 (2022-2026)	Phase 2 (2027-2031)	Phase 3 (2032-2036)	Phase 4 (2037-2041)	Phase 5 (2042-2046)
Capacity	$8.83	$0	$0	$7.18	$1.66	$0
Condition Assessment	$19.87	$2.80	$4.81	$4.09	$4.09	$4.09
Other	$0.17	$0.11	$0.07	$0	$0	$0
Total CIP	**$28.88**	**$2.91**	**$4.87**	**$11.27**	**$5.75**	**$4.09**

Notes:
(1) Costs shown are in millions of dollars.

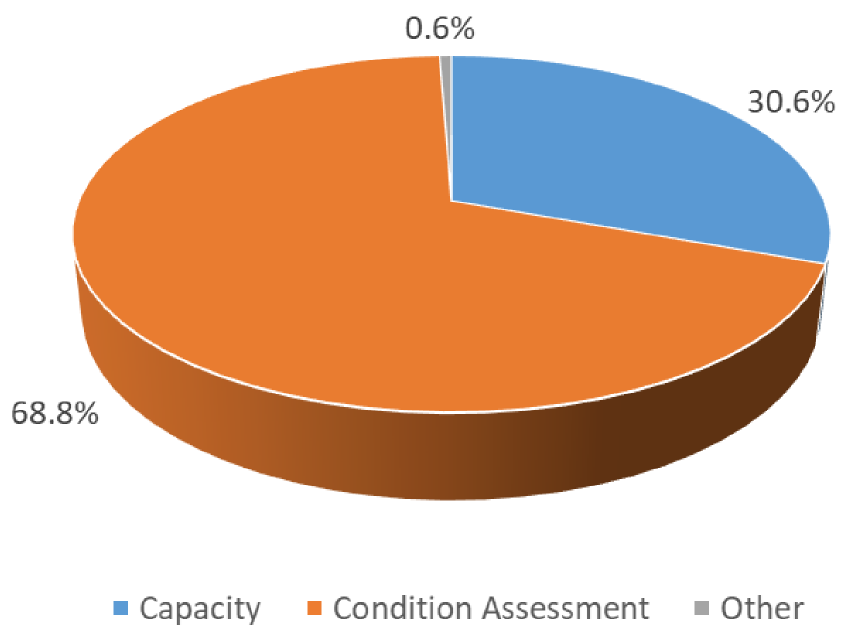

Figure 7.1 25-Year TRI CIP by Project Type

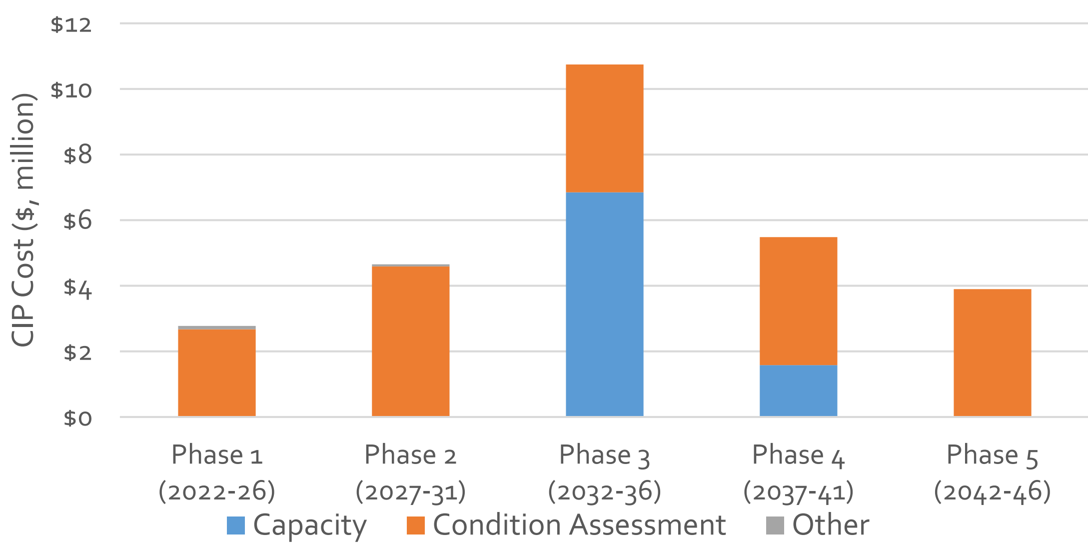

Figure 7.2 25-Year TRI CIP by Project Phase

Appendix 7A

DETAILED TRI CIP COST ESTIMATES

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25-Year TRI CIP

ID	Description	Type	Quantity	Existing Size	Proposed Size	Direct Unit Cost ($/LF)	Total Project Cost (Nov 2021) ($)	Phase 1 ($) 2022	2023	2024	2025	2026	Phase 2 ($) 2027	2028	2029	2030	2031	Phase 3 ($) 2032-36	Phase 4 ($) 2037-41	Phase 5 ($) 2042-46
Capacity Improvements			(ft)	(in)	(in)		$8,830,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,180,000	$1,660,000	$0
C-1	Gravity Main between MH 57 and MH 62	Replace	4,290	24/27	30	$760	$7,180,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$7,180,000	$0	$0
C-2	Gravity Main between MH 71 and MH 72	Replace	990	24	30	$760	$1,660,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,660,000	$0
Condition Assessment Improvements			(ft)	(in)	(in)		$19,870,000	$252,000	$454,000	$1,814,000	$100,000	$180,000	$720,000	$1,021,875	$1,021,875	$1,021,875	$1,021,875	$4,087,500	$4,087,500	$4,087,500
RR-1	River Crossing, Gravity Main between MH 33 and MH 35	Line	1,380	24	24	$830	$2,520,000	$252,000	$454,000	$1,814,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
RR-2	River Crossing, Gravity Main between MH 65 and MH 66	Line	220	30	30	$1,030	$500,000	$0	$0	$0	$50,000	$90,000	$360,000	$0	$0	$0	$0	$0	$0	$0
RR-3	River Crossing, Gravity Main between MH 88 and MH 89	Line	220	30	30	$1,030	$500,000	$0	$0	$0	$50,000	$90,000	$360,000	$0	$0	$0	$0	$0	$0	$0
RR-4	TRI Renewal Program	Line/Replace	Varies	Varies	Varies	Varies	$16,350,000	$0	$0	$0	$0	$0	$0	$1,021,875	$1,021,875	$1,021,875	$1,021,875	$4,087,500	$4,087,500	$4,087,500
Other Improvements							$170,000	$105,000	$0	$0	$0	$0	$65,000	$0	$0	$0	$0	$0	$0	$0
O-1	Visible Reinforcement Study	--	--	--	--	--	$170,000	$105,000	$0	$0	$0	$0	$65,000	$0	$0	$0	$0	$0	$0	$0
Total CIP Cost							$28,875,000	$357,000	$454,000	$1,814,000	$100,000	$180,000	$785,000	$1,021,875	$1,021,875	$1,021,875	$1,021,875	$11,267,500	$5,747,500	$4,087,500
Estimated CIP Annual Cost							$1,155,000	$357,000	$454,000	$1,814,000	$100,000	$180,000	$785,000	$1,021,875	$1,021,875	$1,021,875	$1,021,875	$2,254,000	$1,150,000	$818,000

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